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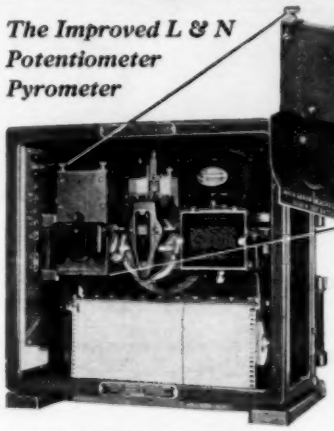

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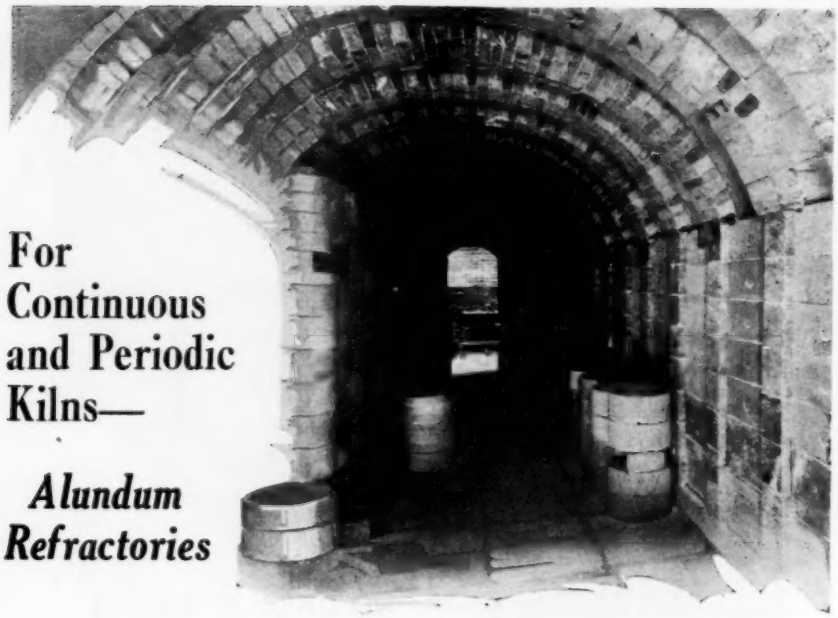

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THE THERMAL EXPANSION OF SOME REFRACTORY OXIDES[1]

By James Bliss Austin

ABSTRACT

The thermal expansion of crystals of alpha-alumina, magnesia, chromite, mullite, and zircon and of a mass of fused zirconia has been measured up to 1000°C. The results are exhibited in tables and in graphical form.

I. Introduction

The thermal expansion of the common refractory oxides has been studied by a number of investigators, but the results are not completely satisfactory since the materials used in making the measurements have not always been well defined with respect to chemical composition and crystalline form. In most cases fragments of commercial brick have been used so that the results are applicable only to brick of similar or but slightly different composition. To obtain some idea of the optimum results which may be achieved with these materials it is essential that the expansion of the several pure components be accurately known.

The ordinary refractory brick is composed of crystals, commonly of a relatively pure component, embedded in a matrix or binder, usually formed by combination of the crystalline material with an impurity or an added fluxing agent. If the dilatation of both crystal and matrix is known, the behavior of the aggregate is more easily understood; it seems reasonable, moreover, to expect that with such data at hand a method for estimating the amount of each constituent present in the aggregate may be devised. With these objects in view an investigation of the expansion of relatively pure crystals of the common refractory oxides was undertaken as a preliminary step in a general study of the expansion of commercial refractories.

II. Apparatus

The Pulfrich-Fizeau interference method as modified by the U. S. Bureau of Standards was employed for making the measurements. The principles of, and apparatus for, this method are fully described in the publications of the Bureau.[2] The only departure from the equipment therein specified was in the design of the furnace, which is shown in Fig. 1.

(1) Furnace A porcelain tube, F, wound with a helical nichrome coil, K, is mounted vertically in a sheet-iron jacket and is surrounded with insulating material, in this case Sil-O-Cel. A smaller tube, E, supports the porcelain cup, C, which contains the interferometer plates, S. A small-bore porcelain tube holding the Pt Pt-10%Rh thermocouple

[1] Received June 9, 1931.

[2] See references 1, 2, and 3, p. 810.

passes through the bottom of the cup, C, the junction being so adjusted that it nearly touches the lower interferometer plate. The upper end of the furnace is closed by another porcelain tube containing the fused quartz windows, W_1 and W_2; W_3 is a glass window. The viewing apparatus is shown at P. The helium line at 5875.6 Å was used as a monochromatic source of illumination. The thermocouple was checked in position in the furnace on the melting points of tin, aluminum, and silver, using standard metals obtained from the Bureau of Standards, on the α-β inversion of quartz and against a quartz refraction thermometer. Temperatures were read on a Leeds and Northrup wall-type potentiometer which had been checked by the Bureau of Standards. It is believed that the temperatures are good to $\pm 1\%$ or better. Figure 2 is a photograph of the apparatus as set up for use with a pair of furnaces.

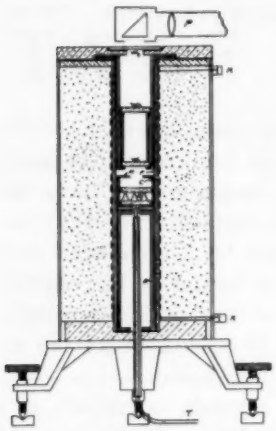

FIG. 1.—Design of furnace and interferometer plates.

(2) Test Pieces The specimens in the interferometer were three small tetrahedra, usually about 0.30 cm. in height, all cut from a single crystal, except in the case of chromite where each specimen was cut from a separate crystal.

III. Presentation of Data

There are in common use two methods of representing expansion data, namely, (1) by means of graphs or (2) by the calculation of a coefficient of expansion, each scheme possessing certain advantages and disadvantages. Experience shows that the coefficient, which gives the rate of change of the dimensions, is more often characteristic than a length-temperature curve since the whole of the latter may be raised appreciably or lowered by disturbing factors while the slope is not affected nearly to the same extent. Yet the coefficient, being in general a mean value over a temperature range, is not particularly sensitive to an inversion point and for this reason may be misleading. On the other hand, a graph makes such discontinuities immediately apparent

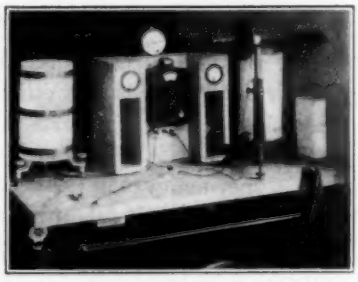

FIG. 2.—General view of apparatus with a pair of furnaces.

and shows at a glance the qualitative behavior of the substance as well as the order of magnitude of its expansion. Because each of these systems has uses to which it is peculiarly adapted, both are employed in presenting the data in this paper.

The curves are plotted in terms of temperature in degrees centigrade against elongation in per cent of the length at 20°C or 25°C, depending on the particular case. They speak for themselves and require no further comment. For the convenience of those who may desire more accurate values than the printed curves afford and who wish to reconstruct the curves on a large scale, the expansion, expressed in per cent of the length at 20°C or 25°C, is also given in tabular form.

For those who prefer coefficients, tables of the mean coefficient, the quantity α in the equation $l_t = l_0 (1 + \alpha t)$, are given. All the observations have been made on linear dilatation but when the expansion along each of the axes of the crystal is known the volume change may be calculated by the expression $\beta = \alpha_1 + \alpha_2 + \alpha_3$, where β is the coefficient of cubical expansion and α_1, α_2, and α_3 are the linear coefficients for the various axes. If two axes are equivalent, then $\beta = \alpha_1 + 2\alpha_2$ and for an isotropic substance, $\beta = 3\alpha$. These last equations, while not rigorous, give, nevertheless, very close approximations. Values of the true coefficient of dilatation, *i.e.*, $\frac{dl}{dt}$, are not given but these may readily be calculated from the total expansion data.

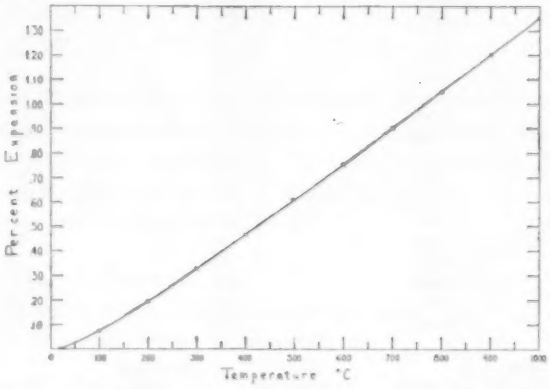

FIG. 3.—Thermal expansion curve for pure fused magnesia.

IV. Results

(1) **Magnesia (MgO)** The magnesia specimens were cut from a large clear colorless crystal obtained from the Norton Company. No analysis of this material was made, but in view of the fact that it was prepared by the fusion of pure MgO, and since it crystallized in colorless well-formed crystals, it was thought to be quite pure. The total expansion in per cent and the mean coefficients are given in Table I; the mean linear coefficients reported by previous investigators are given

in Table I*a* for the sake of comparison. The data in the first column of Table I are plotted in Fig. 3.

Of previous workers, only Norton and Merritt have used material comparable with that employed in the present determination. A careful comparison of their data with those of Table I shows complete agreement,

TABLE I

TOTAL EXPANSIONS AND MEAN COEFFICIENTS OF MgO

Temp. (t°C)	Total expansion in % of the length at 20°	Mean linear coefficient $\times 10^6$ $(20°-t°)$ α	Mean volume coefficient $\times 10^6$ $(20°-t°)$ $\beta = 3\alpha$
20	0	0	0
50	0.012	6.66	19.98
100	0.073	9.11	27.33
150	0.135	10.38	31.14
200	0.196	10.88	32.64
250	0.260	11.30	33.90
300	0.325	11.61	34.83
350	0.395	11.96	35.88
400	0.462	12.15	36.45
450	0.535	12.45	37.35
500	0.607	12.65	37.95
550	0.680	12.83	38.49
600	0.752	12.96	38.88
650	0.825	13.10	39.30
700	0.900	13.23	39.69
750	0.975	13.35	40.05
800	1.050	13.46	40.38
850	1.125	13.55	40.65
900	1.200	13.63	40.89
950	1.275	13.70	41.10
1000	1.350	13.77	41.91

TABLE I*a*

SUMMARY OF EXISTING DATA ON MgO

Material	Mean linear coefficient $\alpha \times 10^6$	Temp. range (°C)	Author	Reference
Periclase	10.43	0–120	Fizeau	6
Fused MgO	$11.40 + 0.0092\ (t-120)$	120–270	Goodwin and Mailey	8
Magnesite brick (76.4% MgO)	12.55	20–1000	Tadokoro	13
Magnesia fired to cone 9 (80% MgO)	12.7	15–1000	Houldsworth and Cobb	14
Magnesite brick (88% MgO)	15.5	15–1000	Bogitch	15
Magnesite brick	13.6	0–1400	Rieke	16
Grecian magnesite brick (89% MgO)	14.2	0–1700	Norton	17
Pure fused magnesia (95.0% MgO)	13.4	20–800	Merritt	18
Magnesite brick	9.9–16.4	20–1300	Hirsch	22
Magnesite*	12.0	20–850	U. S. Bureau of Standards	23
Magnesite brick	12.7	15–1350	Mellor	12

Cf. also reference 28, p. 810.

* Called "magnesite" by author. Its exact composition is not clear.

particularly in the case of the values of Merritt, which agree, within the experimental error with those of the present writer over the whole temperature range. The observations of Tadokoro, who used an impure sample, show an appreciably smaller expansion, indicating in a qualitative way that the nearer the sample approaches to pure MgO, the greater is the expansion.

(2) Alpha-Alumina (Corundum) (Al_2O_3) Two sets of specimens of Al_2O_3 were examined. The material for the first set, a mass of alpha-alumina, also furnished by the Norton Company, was an aggregate of fine crystals and had the following composition according to an analysis made by W. D. Brown of the Carnegie Steel Company.

	(%)		(%)
Al_2O_3	99.95	CaO	None
SiO_2	0.10	MgO	None
Fe_2O_3	0.26	ZrO_2	None
TiO_2	None		

The second set was cut from a blue Indian sapphire, the specimens being oriented so that the expansion both parallel to the principal axis and perpendicular to it could be measured. The total expansion in per cent and the mean coefficients are given in Table II and Fig. 4. A review of previous measurements is given in Table II*a*.

TABLE II

TOTAL EXPANSION AND MEAN COEFFICIENTS OF ALUMINA

(Values in parentheses are extrapolated)

Temp. (t°C)	Aggregate Total expansion in % of length at 20°	Sapphire Total expansion in % of length at 20°		Aggregate Mean linear coefficient $\times 10^6$ $(20°-t°)$ α	Sapphire Mean linear coefficient $\times 10^6$ $(20°-t°)$		Aggregate Volume coefficient $\times 10^6$ $(20°-t°)$ $\beta = 3\alpha$	Sapphire Volume coefficient $\times 10^6$ $(20°-t°)$ $\beta = \alpha_1 + 2\alpha_2$
		∥ prin. axis	⊥ prin. axis		∥ prin. axis	⊥ prin. axis		
20	0	0	0	0	0	0	0	0
50	0.010	0.20	0.015	3.3	6.66	5.0	9.9	16.66
100	0.032	0.055	0.044	4.0	6.87	5.5	12.0	17.87
150	0.055	0.090	0.078	4.23	6.92	6.0	12.69	18.92
200	0.085	0.130	0.112	4.72	7.22	6.21	14.16	19.64
250	0.110	0.175	0.150	4.78	7.60	6.52	14.34	20.64
300	0.140	0.218	0.192	5.00	7.78	6.86	15.00	21.50
350	0.170	0.258	0.233	5.15	7.84	7.01	15.45	21.86
400	0.200	0.302	0.278	5.26	7.94	7.31	15.78	22.56
450	0.231	0.350	0.323	5.38	8.14	7.51	16.14	23.16
500	0.265	0.400	0.370	5.52	8.33	7.70	16.56	23.73
550	0.300	0.444	0.410	5.66	8.37	7.74	16.98	23.85
600	0.332	0.490	0.455	5.72	8.44	7.84	17.16	24.12
650	0.368	0.545	0.500	5.84	8.65	7.93	17.52	24.51
700	0.395	0.593	0.545	5.80	8.72	8.01	17.40	24.74
750	0.430	0.640	0.588	5.89	8.77	8.05	17.67	24.87
800	0.463	0.685	0.632	5.93	8.78	8.10	17.79	24.98
850	0.495	0.730	0.678	5.96	8.79	8.17	17.88	25.13
900	0.528	0.780	(0.725)	6.00	8.86	8.23	18.00	25.32
950	0.558	0.832	(0.770)	6.00	8.94	8.28	18.00	25.50
1000	0.590	0.885	(0.815)	6.01	9.03	8.31	18.03	25.65

It will be seen at once from Fig. 4 that the expansion parallel to the principal axis in the crystal is greater than that perpendicular to it; moreover, the expansion in each direction in the crystal is greater than in the crystalline aggregate. This latter condition may be attributed to some internal rearrangement of the small crystals of the aggregate but since such an explanation has no real meaning unless the motions of the parts can be specified and since there is no indication that the dilatation of an aggregate is always less than that of a single crystal, further speculation on this basis does not seem justified. Indeed, it appears that the expansion of this particular aggregate is less than that of aggregates used by other investigators (see Table II*a*).

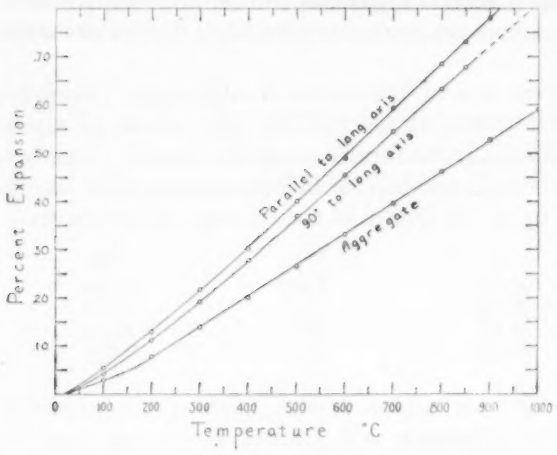

FIG. 4.—Thermal expansion curves for aggregate of alpha-alumina and for a sapphire.

TABLE II*a*

REVIEW OF EXPANSION DATA ON ALUMINA

Material	Mean linear coefficient $\alpha \times 10^6$	Temp. range (°C)	Author	Reference
Blue Indian sapphire	∥ prin. axis = 6.19 ⊥ prin. axis = 5.43	0–120	Fizeau	5
Sapphire	∥ prin. axis = 6.55 ⊥ prin. axis = 6.87	0–100	Pfaff	4
Fused Al_2O_3 (95.5%)	7.7 8.2	0–1600 300–700	Norton	17
Al_2O_3 (99%) + $AlCl_3$ binder	7.9	25–800	Merritt	18
Alundum grains	7.0 8.6	20–500 20–850	Shearer and Wyckoff	19
Corundum fired to cone 16	7.9	20–990	U. S. Bureau of Standards	23
Corundum brick (64% Al_2O_3)	6.38	20–1000	Schulz and Kanz	27
Corundum brick (82% Al_2O_3)	7.8	20–100	Kratzert and Immke	21
Corundum	8.6	20–1750	U. S. Bureau of Standards	30

It is interesting to note that there occurs in the expansion curves two slight breaks indicated by small though definite changes in slope. The greater change, occurring at approximately 250°C, is observed in the expansion in both directions; the smaller occurs at about 400°C and, though clearly indicated in the expansion perpendicular to the principal axis of the crystal, appears to be lacking in the expansion parallel to the principal axis. These points have also been observed by Cohn,[3] who finds them at approximately the same temperatures. Similar breaks are observed in other materials, for example, zirconia, as will be seen later. Thus far no satisfactory explanation of them has been given.

(3) Zirconia (ZrO_2) The zirconia examined was calcined electrically-fused zironium oxide furnished by the Titanium Alloy Manufacturing Company of Niagara Falls, N. Y., through the courtesy of A. Thompson, and had the following composition according to an analysis made by them:

	(%)
ZrO_2	97.69
Al_2O_3	1.00
SiO_2	0.24
TiO_2	0.50
Fe_2O_3	0.25

It came in the form of long basalt-like columns which showed a different expansion parallel and perpendicular to the long axis. The total ex-

TABLE III

TOTAL EXPANSION AND MEAN COEFFICIENTS OF ZIRCONIA

Temp. (t°C)	Total expansion in % of length at 20°		Mean linear coefficient $\alpha \times 10^6$ $(20°-t°)$		Mean volume coefficient $\beta \times 10^6$ $(20-t°)$ $\beta = \alpha_1 + 2\alpha_2$
	∥ axis of columns	⊥ axis of columns	⊥ axis of columns α_2	∥ axis of columns α_1	
20	0	0	0	0	0
50	0.015	0.025	8.3	5.0	21.6
100	0.040	0.058	7.2	5.0	19.4
150	0.065	0.093	7.16	5.0	14.82
200	0.095	0.133	7.39	5.26	15.28
250	0.120	0.173	7.53	5.21	20.27
300	0.150	0.220	7.85	5.35	21.05
350	0.178	0.260	7.89	5.38	21.16
400	0.205	0.308	8.10	5.40	21.60
450	0.238	0.355	8.26	5.53	22.05
500	0.270	0.400	8.34	5.62	22.30
550	0.295	0.440	8.30	5.56	22.16
600	0.321	0.487	8.39	5.53	22.37
650	0.353	0.531	8.42	5.56	22.40
700	0.380	0.571	8.39	5.59	22.37
750	0.410	0.620	8.48	5.61	22.57
800	0.437	0.675	8.65	5.60	22.90
850	0.470	0.730	8.79	5.66	23.24
900	0.500	(0.785)	8.92	5.68	23.52
950	0.530			5.70	
1000	(0.560)			5.72	

[3] See reference 35, p. 810.

pansion in per cent and the mean coefficients are given in Table III and Fig. 5. The few reliable data on zirconia found in the literature are collected in Table III*a*.

TABLE III*a*

REVIEW OF DATA ON ZIRCONIA

Material	Mean linear coefficient $\alpha \times 10^6$	Temp. Range (°C)	Author	Reference
Zirconia ore (60.4% ZrO_2)	8.7	300–700		
	5.9	0–1600	Norton	17
Specially purified ZrO_2 fused with organic binder	∥ axis = 8.1	20–800	Merritt	18
	⊥ axis = 7.3			
	agg. = 6.6			
Pressed and sintered ZrO_2	4.5	20–1300	Becker	20
Brick	7.2	20–100	Kratzert and Immke	21
Brick 52% ZrO_2	5.24	20–1000	Schulz and Kanz	27
Sintered ZrO_2	8.81	0–1000	Cohn	29

For earlier work see references 9, 10, 11, 25, p. 810.

On comparing the present data with those reported for crystalline ZrO_2 by Merritt,[4] it was found that his measurement of the expansion perpendicular to what he calls the "long" axis of the crystals agrees with that in a direction parallel to the length of the columns used by the present author, and that his coefficient for expansion parallel to the "long" axis agrees with the coefficient for expansion perpendicular to the length of the columns.

When informed of this discrepancy Mr. Merritt kindly furnished the author with a sample of his material to be used in further study. This specimen also occurred in elongated columns which were, however, much smaller than those of the author's zirconia.

It was thought at first that perhaps the two materials might be different forms since Cohn has shown[5] that several exist. An examination under the petrographic microscope showed, however, that their indices of refraction were identical, indicating that both specimens were of the same modification. The examination also showed that in neither case did the columns represent single crystals, but were rather cooling columns such as are sometimes found in basalt rocks. A thin section of the author's zirconia gave some evidence, though not conclusive, that the crystals are so oriented within the columns that their principal axes are perpendicular to the length of the columns. This, if true, brings the observations of Merritt and the author into agreement since a previous study of the optical

[4] See reference 18, p. 810.

[5] See reference 34, p. 810.

properties of his material indicated that the principal axis of the crystals was probably aligned with the length of his columns. It is interesting to note that while the small crystals which make up the columns are oriented, as is well established by the different expansion in different directions, their orientation is not always the same; thus their principal axes may apparently be aligned either with the length of the column or perpendicular to it.

In view of the fact that zirconia crystallizes in the monoclinic system and has, therefore, a coefficient for each of the three different axes in the crystal, the two coefficients obtained for the columns probably are not true coefficients but are rather an average over the oriented crystals in the columns. If well-defined single crystals of suitable size of either artificial ZrO_2 or of baddeleyite were available the question could be definitely settled but so far the author has failed to locate any such specimens. The volume expansion given in Table III has, therefore, been calculated by treating the columns as if they were hexagonal crystals ($\beta = \alpha_1 + 2\alpha_2$).

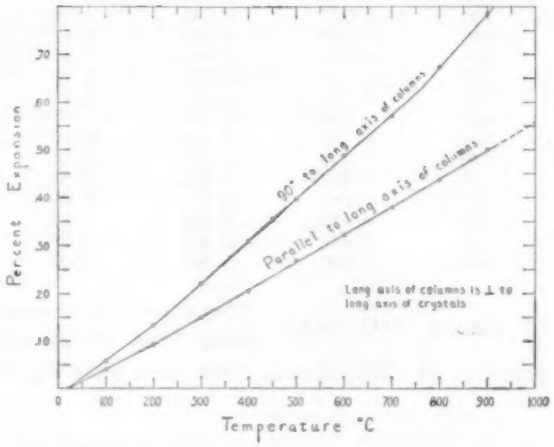

FIG. 5.—Thermal expansion curves for fused zirconia.

Of the other investigations that of Cohn[6] is by far the most complete. He has examined a great number of specimens and finds that the expansion is not independent of the history of the specimen but depends upon the firing temperature and length of the firing period. In general his determinations lie between the two curves shown in Fig. 5. This is to be expected since, insofar as one can tell, his work was done with aggregates exhibiting no tendency toward preferred orientation.

It should be noted that at about 225°C and 750°C there are observed small sudden changes in the slope of the expansion curves which are quite similar to the changes found in the sapphire. These changes, which are more pronounced in the direction perpendicular to the axes of the columns, have also been observed by Cohn.[6] In one case a small

[6] See reference 36, p. 810.

hysteresis, not shown in Fig. 5, was observed around 600°C. This has also been observed by Cohn[6] in the case of a zirconia rod fired at 1900°, except that his curve for cooling is below, whereas in the present case the curves for cooling are above the curve for heating.

TABLE IV

TOTAL EXPANSION AND MEAN COEFFICIENTS OF ZIRCON ($ZrO_2 \cdot SiO_2$)

Temp. (t°C)	Total expansion in % of length at 25°		Mean linear coefficients $\alpha \times 10^6$ $(25° - t°)$		
	∥ prin. axis	⊥ prin. axis	∥ prin. axis α_1	⊥ prin. axis α_2	Volume coefficient $\beta \times 10^6$ $(25° - t°)$ $\beta = \alpha_1 + 2\alpha_2$
25	0	0	0	0	0
50	0.010	0.006	4.0	2.0	8.0
100	0.032	0.018	4.2	2.4	9.0
150	0.058	0.032	4.64	2.56	9.76
200	0.082	0.046	4.68	2.63	9.94
250	0.112	0.061	4.98	2.71	10.40
300	0.142	0.078	5.16	2.84	10.84
350	0.172	0.092	5.29	2.83	10.95
400	0.204	0.110	5.44	2.93	11.30
450	0.238	0.128	5.60	3.01	11.62
500	0.271	0.147	5.70	3.09	11.88
550	0.308	0.170	5.86	3.24	12.34
600	0.344	0.192	5.98	3.34	12.66
650	0.380	0.218	6.08	3.49	13.06
700	0.413	0.238	6.12	3.53	13.18
750	0.448	0.261	6.18	3.60	13.38
800	0.480	0.284	6.19	3.66	13.51

(4) Zircon ($ZrO_2 \cdot SiO_2$) The zircon specimens were cut from a large clear blue zircon crystal originating in the province of Chantaboon, Siam, and showing the following composition as determined by W. D. Brown of the Carnegie Steel Company. (ZrO_2 69.0%; SiO_2 29.90%.) By properly cutting the specimens the expansion in various directions in the crystal could be measured. Table IV and Fig. 6 give the total expansion in per cent and the mean coefficients. These coefficients represent the reproducible expansion of the material after several heatings and are not first runs, since the latter were frequently very erratic. For example, the first run on the expansion perpendicular to the principal axis of the crystal gave the peculiar curve shown

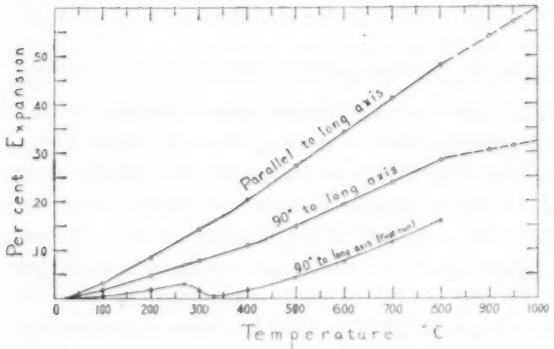

FIG. 6.—Thermal expansion curve for a zircon crystal.

in Fig. 6. Later runs were much more regular although above about 800° a small irreversible contraction was observed. This is thought to be due to a softening of the specimen and is probably not a characteristic of the zircon; hence, no values of the coefficient above 800° have been given in the tables. The curves of Fig. 6 give the magnitude of this contraction. Curiously enough, the clear blue specimens turned to an opaque white with a slight yellowish cast during the course of the heatings. As the specimens were not removed from the furnace between runs, it is not possible to say whether the bleaching occurred during the first run or gradually during the several runs.

Table IV*a* gives a summary of the existing data.

TABLE IV*a*

SUMMARY OF EXPANSION DATA ON ZIRCON

Material	Mean linear coefficient $\alpha \times 10^6$	Temp. range (°C)	Author	Reference
Zircon crystal	∥ prin. axis 11.05 ⊥ prin. axis 6.3	0–100	Pfaff	4
Crystal	∥ prin. axis 4.43 ⊥ prin. axis 2.33	0–120	Fizeau	7
White zircon sand (66.4% ZrO_2)	9.2 6.4	300–700 0–1500	Norton	17
Zircon fired to cone 16	4.5	20–900	U. S. Bureau of Standards	23
Florida zircon	4.5	20–850	Shearer and Wyckoff	19

The determinations by Fizeau are in good agreement with those of the author while those of Pfaff are decidedly larger. Of the others it need only be said that being made on aggregates agreement cannot be expected. They are, however, all of the same order of magnitude and serve to demonstrate the very low expansion of this material.

(5) Mullite ($3Al_2O_3 \cdot 2SiO_2$) Unfortunately no large single crystal of mullite suitable for this purpose was available so the nearest approach to it, a mass of long slender needles bonded with a bit of glassy slag, was obtained from the Corning Glass Works. With this sample it was possible to estimate, at least, the expansion in the different directions in the crystal. Its composition as determined by W. D. Brown of the Carnegie Steel Company was as follows:

	(%)		(%)
Al_2O_3	62.32	Fe_2O_3	0.40
SiO_2	34.30	CaO	0.52
TiO_2	1.92	MgO	0.56

Table V and Fig. 7 give the numerical data of the present investigation.

The curves shown in Fig. 7 and the data of Table V are given for the first runs on the specimens. Subsequent runs yielded curves which were displaced downward as compared to the first but whose curvatures were very nearly the same. This indicates a slight irreversible contraction on heating which is probably due to a softening of the glassy bond.

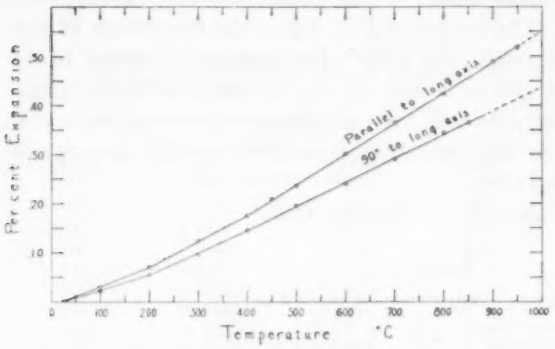

FIG. 7.—Thermal expansion curves for mullite.

The previous work is reviewed in Table V*a*. The only comment required is that the other determinations are lower than the present ones.

(6) Chromite The chromite, part of sample No. R-1993 of the U. S. National Museum, was obtained through the courtesy

TABLE V

EXPANSION AND MEAN COEFFICIENTS OF MULLITE ($3Al_2O_3 \cdot 2SiO_2$)

Temp. (t°C)	Total expansion in % of length at 25°		Mean linear coefficient $\alpha \times 10^6$ $(25° - t°)$		Mean volume coefficient $\beta \times 10^6$ $(25° - t°)$ $\beta = \alpha_1 + 2\alpha_2$
	∥ prin. axis	⊥ prin. axis	∥ prin. axis α_1	⊥ prin. axis α_2	
25	0	0	0	0	0
50	0.010	0.008	4.00	2.94	9.88
100	0.030	0.022	4.00	3.20	10.40
150	0.050	0.040	4.00	3.20	10.40
200	0.070	0.056	4.00	3.20	10.40
250	0.095	0.078	4.22	3.47	11.16
300	0.123	0.095	4.47	3.45	11.37
350	0.150	0.120	4.61	3.69	11.99
400	0.175	0.145	4.66	3.87	12.40
450	0.208	0.165	4.90	3.89	12.68
500	0.235	0.195	4.95	4.11	13.17
550	0.270	0.218	5.14	4.15	13.44
600	0.300	0.240	5.22	4.17	13.56
650	0.332	0.270	5.31	4.32	13.95
700	0.365	0.290	5.40	4.30	14.00
750	0.395	0.316	5.45	4.36	14.17
800	0.425	0.345	5.49	4.45	14.39
850	0.455	0.365	5.51	4.43	14.37
900	0.490	(0.390)	5.60	4.46	14.52
950	0.518	(0.415)	5.60	4.49	14.58
1000	(0.553)	(0.440)	5.66	4.51	14.68

of W. F. Foshag of that institution. It was collected at Democrat, N. C., and occurred as octahedral crystals which were easily fashioned into suit-

TABLE V*a*

SUMMARY OF EXPANSION DATA ON MULLITE

Material	Mean linear coefficient $\alpha \times 10^6$	Temp. range (°C)	Author	Reference
Fine-grained crystals	5.3	0–1700	Norton	17
Grains	4.1	20–50	Shearer and Wyckoff	19
	5.4	20–1400	U. S. Bureau of Standards	26
Brick	5.1	20–1000	Kratzert and Immke	21

able specimens. According to an analysis by W. D. Brown of the Carnegie Steel Company it has the following composition:

	(%)
Cr_2O_3	57.18
Fe_2O_3*	21.66
MgO	7.30
CaO	2.31
Ign. loss	3.41

* Ferrous and ferric iron not separated.

Table VI and Fig. 8 give the expansion data while Table VI*a* gives a review of the data recorded in the literature.

TABLE VI

TOTAL EXPANSION AND MEAN COEFFICIENTS FOR CHROMITE

Temp. (t°C)	Total expansion in % of length at 20°	Mean linear coefficient $\alpha \times 10^6$ (20°–t°)	Mean volume coefficient $\beta \times 10^6$ (20°–t°) $\beta = 3\alpha$
20	0	0	0
50	0.018	6.00	18.00
100	0.045	5.67	17.01
150	0.080	6.15	18.45
200	0.118	6.56	19.68
250	0.155	6.72	20.16
300	0.198	7.07	21.21
350	0.238	7.21	21.63
400	0.287	7.55	22.65
450	0.325	7.55	22.65
500	0.370	7.70	23.10
550	0.415	7.83	23.49
600	0.462	7.96	23.88
650	0.508	8.06	24.18
700	0.551	8.10	24.30
750	0.600	8.21	24.63
800	0.648	8.30	24.90
850	0.685	8.25	24.75
900	0.730	8.30	24.90
950	0.763	8.20	24.60
1000	0.798	8.13	24.39

There seems to be substantial agreement between the determinations of Kratzert and Immke, Schulz and Kanz, and the present writer. The values of Norton and Tadokoro are somewhat higher. The sudden expansion found by Norton about 900°C is not confirmed by other observers.

TABLE VI*a*

REVIEW OF EXPANSION DATA ON CHROMITE

Material	Mean linear coefficient $\alpha \times 10^6$	Temp. range (°C)	Author	Reference
Chrome brick	9.02	20–1000	Tadokoro	13
Chrome brick	12.4 11.4	300–700 0–154	Norton	17
Cuban chrome ore	7.0 to 8.5	0–1000	U. S. Bureau of Standards	23
Brick	10.7	0–1500	Kothny	24
Brick	8.1	20–1000	Kratzert and Immke	21
Brick	8.45	20–1000	Schulz and Kanz	27
	7.0	20–1000	Portevin and Chevenard	28
Brick	11.0	20–1000	Bogitch	15
African ore	7.0 to 8.5	20–1000	U. S Bureau of Standards	31

V. Recapitulation and General Discussion

To show the relative magnitudes of the dilatations of these oxides, the total linear expansion of each between 20°C and 1000°C expressed as parts per 10,000, is given in Table VII. The data of Kozu and Saiki on quartz[7] have also been included since the widespread knowledge of its behavior makes it a convenient reference.

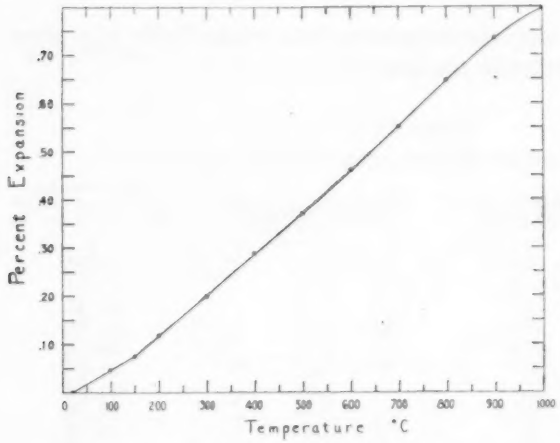

FIG. 8.—Thermal expansion curve for chromite.

Thus we see that after quartz magnesia has the greatest expansion; alpha-alumina and zirconia, about alike, are next in order; chromite follows closely, while mullite and zircon are lowest in the series of substances studied.

These relations are of some importance, as for example, in the estimation of spalling tendency, which other things being equal, is proportional to the expansion. From this point of view zircon and mullite would be the most desirable. There is, however, another factor to be considered. Curiously enough, the order of decreasing expansion for the group studied is the same as the order of decreasing thermal conductivity, according to measurements by Norton,[8] which are given in column three of Table VII. (Conductivity data are not included for quartz since the profound changes

[7] See reference 32, p. 810.

[8] See reference 33, p. 810.

which it suffers at its inversion point are not duplicated in the other oxides; hence comparison in this case is hardly justified.) Spalling tendency appears to be inversely proportional to some function of the thermal conductivity; other things being equal, therefore, the influence of this

TABLE VII

Material	Total expansion between 20° and 1000°C in parts per 10,000	Thermal conductivity of brick at 500°C × 10^4
Quartz (SiO_2)	∥ prin. axis 87	
	⊥ prin. axis 169	
Magnesia (MgO)	135	103
Alpha alumina (Al_2O_3)	aggregate 59	
	sapphire ∥ prin. axis 89	82
	⊥ prin. axis 82	
Zirconia (ZrO_2)	∥ prin. axis 56	42
	⊥ prin. axis 89	
Chromite ($FeO \cdot Cr_2O_3$)	80	39
Zircon ($ZrO_2 \cdot SiO_2$)	∥ prin. axis 60	
	⊥ prin. axis 33	
Mullite ($3Al_2O_3 \cdot 2SiO_2$)	∥ prin. axis 55	
	⊥ prin. axis 44	

factor may be greater than that of the expansion. As to how far this relation between expansion and thermal conductivity is a general one remains to be seen but it is hoped that work on the thermal conductivity of refractories about to be undertaken in this laboratory may elucidate this point.

There appears to be no conclusive evidence at hand as to the relative expansions of a single crystal and an aggregate. From a study of the existing data it would seem that the expansion of a porous aggregate lies in some cases, below that of a single crystal, and in others, between the expansions parallel and perpendicular to the principal axis; only rarely does it lie above that of a single crystal.

There is also an indication that, to a limited extent, the expansion of a pure specimen is greater than that of an impure one. Thus the closer the composition approaches that of the pure oxide, such as MgO, or that of a simple combination such as $ZrO_2 \cdot SiO_2$, the greater will be the expansion.

This relation, if general, implies that a diagram in which expansion over a given temperature range is plotted against composition will look not unlike a melting point diagram, a maximum being associated with the occurrence of a compound. It also implies that the expansion of a commercial brick will be somewhat lower than that of its chief constituent in the pure crystalline state, an effect which would be in addition to the effect caused by the fact that the brick is a porous aggregate.

Acknowledgment It is a pleasure to acknowledge the coöperation of the Norton Company, the Corning Glass Company, the Titanium Alloy Manufacturing Company, and the National Museum in Washington in the matter of

securing samples. We are also indebted to W. D. Brown, Chief Chemist, Duquesne Works of the Carnegie Steel Company for many of the analyses and to G. E. Merritt of the Bureau of Standards for much helpful advice on the manipulation of the apparatus.

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THE STRENGTH OF GLASS AS AFFECTED BY CASING[1]

By James Bailey

ABSTRACT

Considerable regarding the strengthening of glass by surface chilling has been written. Theoretically it has been shown that the modulus of rupture of slabs of toughened glass may have a maximum of 3.4 times that of annealed glass. Complicated shapes and large surfaces cannot be satisfactorily treated by this method.

Very similar results may be obtained by the method commonly called "casing," wherein the article consists of three layers, the two outer ones being of glass having a lower coefficient of expansion than the inner layer.

After annealing in the usual way the outer layers are left in compression and the central layer is in tension. By combining these initial stresses with those set up during a test to determine the modulus of rupture, a set of equations was derived. These equations were expressed in graph form, one of which gave the relation of case thickness expressed in tenths of the total thickness to the relative strength compared to flawless annealed glass. A number of curves were shown based upon the ratio of maximum internal tension to the maximum tension at the surface. These curves enabled the proper case thickness to be found in order to develop optimum strength for any assumed ratio of maximum internal tension to external tension.

Another graph showed the corresponding initial tension and compression due to casing for the conditions outlined above. These curves showed that the case thickness could vary considerably without greatly affecting the strength and also that the initial stresses are smaller than those usually thought necessary.

The maximum relative strength as developed by "casing" had a somewhat smaller value than that developed by "toughening."

I. Introduction

The method of cutting glass by scoring with a diamond is a demonstration of the effect that surface imperfections have upon the apparent strength of glass.

A piece of glass so cooled as to leave its surface in compression cannot be cut by diamond scoring, and the customary tests would indicate a decided increase in the apparent strength. Glass articles so treated have been reputed to be almost nonbreakable. The most common method of producing such articles is to chill the glass from above the annealing range. The subsequent contraction of the hot interior sets up strains such that the surface is left in compression and the interior is left in tension.

Littleton and Preston[2] have discussed this subject under the title, "A Theory of the Strength of Thermally Toughened Glass." The theory is also advanced that glass breaks in tension because of minute flaws. A flaw on the surface exerts twice the influence of a flaw in the interior. Therefore an internal arrangement of strain which tends to confine all

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[1] Presented at the Annual Meeting, American Ceramic Society, Cleveland, Ohio, February, 1931 (Glass Division). Received May 11, 1931.

[2] J. T. Littleton and F. W. Preston, *Jour. Soc. Glass Tech.*, **13**, 336–49 (1929).

tensile stresses to the interior greatly increases the strength. By mathematical means they deduced that an optimum condition of strain would increase the strength of a circular rod in direct tension to $1^1/_2$ times that of an annealed specimen. Similarly the modulus of rupture of a slab tested in bending may be theoretically increased to 3.4 times that of an annealed specimen. Actual tests showed increases amounting to two and one-half times the annealed modulus.

These tests define the benefits to be gained by thermal toughening. In practice, however, it is extremely difficult to apply uniform heat treatment to large surfaces or irregular shapes, and articles such as bottles do not lend themselves to such treatment owing to the inaccessibility of the interior surface.

II. Casing

Similar surface toughening may be produced by the method commonly called "casing." In this system, the article is built up of three layers of glass, the two outer layers having a smaller coefficient of expansion than the interior layer.

An article thus made and annealed in the usual way will be left in a strained condition, which depends upon the hardness of the glass, the relative thickness of the layers, and the difference in the coefficients of expansion of the glasses. If these factors are properly worked out the article will have remarkable resistance to sudden shocks and temperature changes and will not be seriously affected by surface scratches.

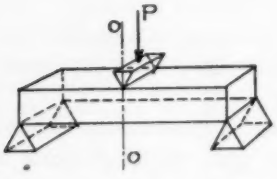


FIG. 1.

NOTE: "Casing" is, of course, applicable to a limited field since two different glasses must be used; however, many of the hand-gathered and blown articles can be made in this way. It has been successfully used for gage tubing, lamp chimneys, and lantern globes. It might also be used for a large variety of tableware. In complicated shapes, the expansions and relative thickness of the layers would necessitate careful control to guard against destructive strains. The present knowledge of glass technology is such that this control presents no very serious difficulty.

(1) Graphic Explanation of Casing

Any attempt to determine the possible increase in strength due to casing must be confined to a simple case since otherwise the stresses become so involved that they cannot be analyzed. The case of a slab of glass tested by bending has therefore been selected for consideration.

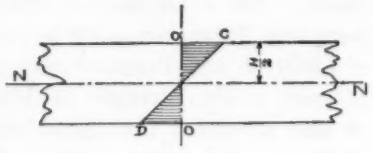


FIG. 2.

Figure 1 shows a slab of annealed homogeneous glass on knife edges

and loaded in the center. The bending moment due to the load, P, may be graphically represented on the line, OO, as is done in Fig. 2. Here the horizontal distance from any point along OO to a point on the line, CD, represents the internal strain. Distances to the right are compression.

In a rectangular beam the neutral axis, NN, will pass through OO at the center. The maximum compression, OC, will equal the maximum tension, DO, and the stress will vary uniformly from NN outward. This stress diagram, which is due solely to the load, P, will be added algebraically to any other strain in the glass due to poor annealing, casing, or other causes.

FIG. 3.

A beam representing the conditions in a cased glass article consists of three layers. The top and bottom layers are of low expansion glass and the central portion is of a glass having a higher coefficient of expansion as shown in Fig. 3.

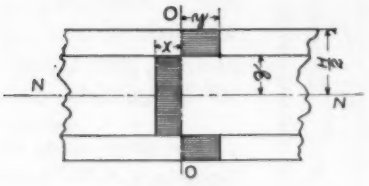


FIG. 4.

After annealing in the usual way, the top and bottom layers will be left in a state of compression and the central portion will be in tension as has already been stated. The stress diagram due to its internal strains is given in Fig. 4. When the load, P, is applied the stress diagram (Fig. 2) is added to that of Fig. 4, giving the resultant stresses as in Fig. 5.

It can immediately be seen that the compression along the top surface has been greatly increased while the tension along the bottom surface has been correspondingly diminished. The value of the maximum compression is not important since glass is more than ten times as strong in compression as in tension. The maximum tension has shifted so that it now occurs along the boundary between the lower outer layer and the inside. This region is not subject to mechanical injuries since it is in the interior of the glass and rupture is not liable to occur until the stress approaches the ultimate tensile strength. The stress in the outer surface depends upon the thickness of the case and the initial strain and hence under the proper conditions may be made too small to permit surface injuries to weaken the glass seriously.

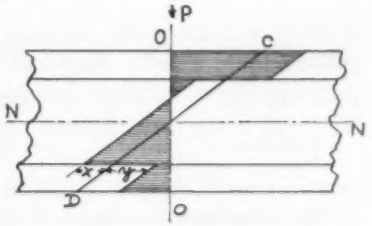


FIG. 5.

(2) Mathematical Explanation of Casing In Fig. 6 let

x = initial tension due to casing
y = initial compression due to casing
S = maximum stress due to load, P
t = resultant tensile stress in outer surface
T = tensile stress alone (EI). (When breakage occurs this will be equal to the ultimate tensile strength of the glass.)

The law of equilibrium requires that the sum of all the tensile stresses (x) must be equal to the sum of all the compressive stresses (y) as in Fig. 4.

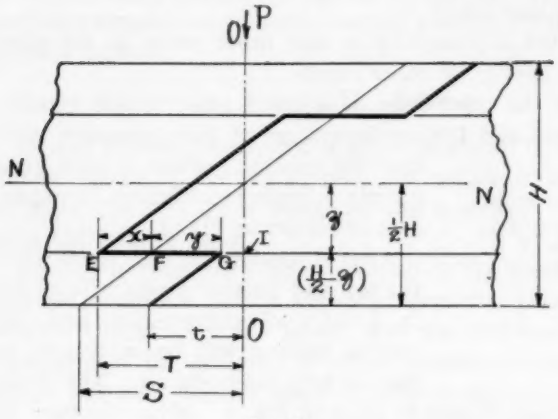


FIG. 6.

The initial condition therefore is as follows:

$$2Wxz = 2Wy\left(\frac{H}{2} - z\right)$$

Where W = the width of beam

Therefore,

$$x = \frac{y}{z}\left(\frac{H}{2} - z\right) \quad (1)$$

The stress along the boundary $EFGI$ is the result of the initial stress added to that due to the load, P.

The tensile stress due to P on this line is

$$FI = \frac{z}{\frac{1}{2}H}(S) = \frac{2Sz}{H}$$

The initial tension is x. The total tension along this line is

$$EI = T = FI + x$$

Therefore

$$T = \frac{2Sz}{H} + x \quad (2)$$

The resultant tension, t, in the lower surface is evidently the difference between the induced stress due to the load, P, and the initial compression.

Therefore,

$$t = (S - y) \quad (3)$$

These three equations enable x, y, and S to be computed for various assumed values of case thickness, when t is expressed in terms of T.

When x and y are zero, the specimen is composed of a single piece of annealed glass and $t = S = T$.

The conditions which discount surface defects and show increased

mechanical strength are those where t is a fraction of T. These are the cases for which solutions have been worked out.

The curves showing the relation between the ultimate strength of cased glass bars and similar bars made of annealed homogeneous glass, assuming the latter had no surface imperfections, are given in Fig. 7.

(3) Strength by Casing Greater Than by Annealing

It is interesting to note that casing will produce bars having theoretically one-third more strength than annealed bars of a single glass even when the surface effect is neglected. This occurs when the case is one-fourth the total thickness, and when the stress, t, in the outer fiber equals the stress, T, along the boundary line. Any other combination, no matter what the ratio of t to T should be, is theoretically weaker.

(4) Surface vs. Interior Stresses

In practice, the surface effect is of great importance so that the induced stress at the surface should be much smaller than that occurring in the interior. Littleton and Preston have workedout their formulas on the assumption that the surface stress should be one-half that of the interior. This seems reasonable for specimens in which the surface has not been injured, but in use glass articles often become deeply scored so that the most serviceable glass articles would probably be produced when the maximum surface tension was much less than this.

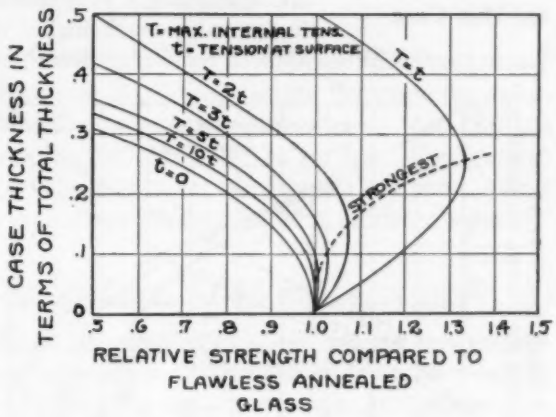


FIG. 7.

The relative strength curves are given in Fig. 7. From these it is seen that the maximum strength for a surface stress of one-third that of the interior, $T = 3t$, occurs when the case is approximately one-tenth of the total thickness and that the strength will then be increased about 3% over that of a flawless annealed specimen.

Similarly the relative strength may be found for any condition ranging from $t = 0$ to $t = T$.

It is interesting to note that the maximum strength is not critical but permits considerable variation in case thickness before any appreciable drop in strength occurs.

As the case thickness approaches zero the values of S and T approach each other so that the final value is unity.

If the exterior tension is limited to one-half the value of the maximum internal tension, then the value of S becomes 0.5 for an uncased piece of annealed glass. The comparative strength of these cased glasses should therefore be doubled in order to be directly comparable to the values obtained by Littleton and Preston.

Figure 8 shows the proper initial tension and compression for any case thickness and any value of T in terms of t.

(5) Relation of Compressive Force to Tensile Strength for Thin Case A study of the curves shows that for a very thin case, the best results require compressive forces which approach a value equal to the ultimate tensile strength. A very thin case might be used which had a value much higher than the tensile strength but in that event the induced tension (x) would be unnecessarily increased and the net result would be a weaker piece of glass.

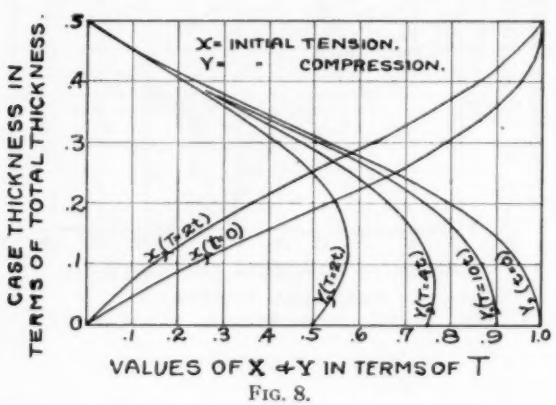


FIG. 8.

(6) Thick Case vs. High Initial Tension Very thick cases result in very high initial tensions, x (see Fig. 8), and should be avoided. In practice a case thicker than 0.2 of the total thickness would be dangerous since the unavoidable irregularities arising in the fabrication of the articles might cause local increases in the thickness that would run the initial tension too close to the ultimate.

(7) Case Thickness vs. Wall Thickness It seems from the curves that for a general rule the case thickness could be made about one-tenth the total thickness of the wall. With casing thicknesses in this region, the initial tension is low enough so that a relatively great difference in the thickness would not result in dangerous stresses. At the same time the comparative strength is not seriously affected by greater or less thickness of the case unless the tension in the surface, t, is held down to a small fraction of the stress along the boundary.

If the condition is made that the surface must never have any tension even when the specimen is loaded to destruction, then $t = 0$ and the initial compression becomes equal to the maximum stress due to the load, P.

With such extreme conditions the case thickness should be kept below 0.12 of the total thickness because of the great rapidity with which the initial stress builds up as the case thickness increases.

Due to the way glass gathers on the blow-iron, thin exterior cases would be hard to produce. The first gather is small, the second gather may have two or three times the amount of glass, and the third gather is usually of greater weight than the sum of the first two. This condition of course would not be permissible. The weight of the gathers must be so adjusted that the proper case thickness develops on both the inner surface of the article and the outer surface. The difficulty of insuring this result makes it advisable to avoid the extreme cases of surface compression and to select a medium ratio such as $T = 4t$. Quite a variation in thickness can then be permitted without endangering the article.

III. Strongest Glasses with Low Internal Stresses

The most interesting disclosure of this study is that the strongest glasses can be made to have relatively low internal tensile stresses, and that the external case is not merely a thin film over the surface. Considerable finishing such as melting off the blow-overs and grinding out punty marks or decorating by etching, etc., could be done without seriously endangering the article.

IV. Annealing Cased Glass on Harder Glass Schedules

Cased glass articles should be annealed in a leer using a temperature schedule designed for the harder glass. When this is done, the resulting strains will be determined by the glass compositions and the workmanship. Neither the shape of the article nor its size will be a major factor in the development of the proper strength. The chief difficulty connected with the production of toughened articles by the chilling or "case hardening" method is thus eliminated.

BAILEY AND SHARP CO., INC.
HAMBURG, N. Y.

Note on the Strength of Glass as Affected by Casing[1]

The Editorial Committee of the Glass Division of the AMERICAN CERAMIC SOCIETY has offered a criticism of the preceding paper. This criticism is that the treatment of the stresses is too qualitative in that the assumption that the stress diagram (Fig. 4) consists of three straight lines, with sudden breaks at the interfaces, the stress in the central piece being a uniform tension, and the stress in the surface layers being a uniform com-

[1] Received August 4, 1931.

pression is not correct. The purpose of this note is to show that this assumption is correct.

The whole matter has already been discussed by F. W. Preston in his paper "Stresses in Wire Glass Due to the Wire,"[2] where it was shown that shear exists only in the region of the boundary surfaces and that therefore the bond between the layers can be removed (except near the edges) without disturbing the stresses in the layers. Quite obviously stresses in this central region would be uniform throughout the layers.

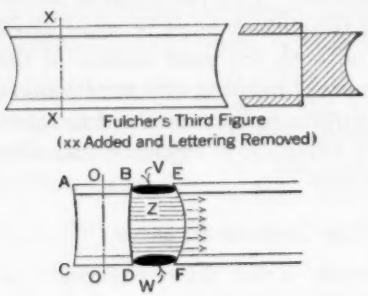


FIG. 9.

For those who are still unconvinced, suppose the edge conditions are visualized and the approximate residual stresses are computed as follows:

(The Editorial Committee has drawn the illustrations of the end conditions which are accepted and have been followed. The third figure is reproduced above without lettering and with the line XX added.)

Suppose such a composite beam is taken and a section is cut off the end at XX.

$ABCD$ (Fig. 9) represents this piece. Its neutral axis is OO, a straight line. Two compression struts, V and W, are placed at the center of the two outer layers and the central layer is united with lines of force, Z. These lines of force are tightened until the face EF becomes a straight line as shown in Fig. 10.

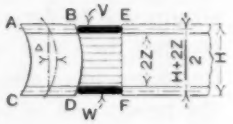


FIG. 10.

It is evident that the stresses to the right of EF are uniform throughout the layers. The piece, $ABCD$, has been bent by these forces until it has deflected the distance, Δ.

Let S equal the stress in the central layer, to the right of EF, then the elastic deformation in the fibers of the central layer will be

$$\Delta_1 = \frac{S}{E}$$

Where E = Young's modulus

The section $ABCD$ is a beam supported at V and W near the ends and loaded uniformly over the region $2Z$. The formula covering deflection of a beam under these conditions is well known. If the maximum stress in $ABCD$ also equals S, and the same elastic constants are assumed, it is only necessary to define Δ in terms of Δ_1 to determine the thickness AB so that Δ may be any small fraction of Δ_1. This works out as follows:

[2] *Jour. Amer. Ceram. Soc.*, **14** [6], 435 (1931).

At a distance in from the edge of three times H, the deflection will have fallen to less than 0.01 of the elastic stretch in the central layers.

At a distance AB = ten times H, it will have fallen to less than 0.001 of the elastic stretch.

From the above it is evident that the end effect approaches zero rapidly and its effect upon the stress diagram need not be considered in cases usually met with in practice where the ratio of length divided by thickness would be of the order of fifty or more.

As an actual fact, nearly all glass articles are forms of revolution. Using for illustration a cased drinking glass, the article would be built up of three layers each of which is a hoop. The inner hoop is compressed by a positive radial pressure between it and the central tension layer. The outer layer is compressed by a radial tension at the boundary between it and the central tension layer. In neither case is any shear present, and therefore, as long as the article were unbroken, the end effect as illustrated by the Editorial Committee would not exist. For this reason it was purposely omitted from the illustrations.

An end effect occurs only at the neck or upper edge of the article. This condition can be satisfactorily taken care of by performing the finishing operation properly, which method is not the subject of this paper.

It is frankly admitted that the analysis of the problem is not exact. One has but to spend a few hours reading "A Treatise on the Mathematical Theory of Elasticity," by E. A. H. Love, to get a visual picture of how the equations would look. Several years of study would be required to get a mental picture, and even then the equations could be used only for simple shapes such as slabs, cylinders, spheres, and cones. Errors in the assumed values of ultimate strength, expansion ratios as functions of the temperature, Poisson's ratio, and variations from the assumed shape as compared to the actual shape manufactured tend to nullify advantages in the use of more accurate treatment. In fact it is extremely doubtful if any ordinary example is subject to much more accurate treatment than that presented in this paper.

The author's paper originally discussed the three-dimensional stresses in considerable detail but during subsequent condensation it was decided to leave out this complicated theory which at best seemed only to befog the problem. It is perhaps to be regretted that more space was not given to the establishment of the analogy between the composite beam with the end effect neglected, as was done in the article, and the unbroken ring as it is found in practice.

AN APPARATUS FOR DETERMINING THE ANNEALING CONSTANTS OF GLASS[1]

By Donald E. Sharp, James Bailey, and Irving Hyman

ABSTRACT

An apparatus is described by means of which annealing data on glass may be rapidly and accurately obtained. Essentially, the apparatus consists of a mechanical means of straining the glass, an optical means of measuring the stresses, and a means of heating the sample uniformly while making the measurement. The results are consistent and expressed in definite terms. The specimens for test may be quite small. The apparatus may be used for control purposes in place of measuring softening temperatures.

I. Introduction

Of the several methods of determining annealing temperatures, the one described by Adams and Williamson[2] has the merit of putting a precise definition on what is commonly a rather indefinite concept. Their method defines the annealing constants of a glass in terms of the temperature at which the stress in a piece of the glass is reduced from a definite amount, to a definite amount in a definite time, or conversely, in terms of time required at a given temperature so to reduce the stress. Their analysis of the subject permits many applications of the annealing data to problems of laboratory and plant which involve the release of stress.

Adams and Williamson conducted all of their tests on samples of optical glass which had been strained by too rapid cooling. They confirmed the conclusions of Twyman[3] that the mobility of glass in the annealing range was a simple exponential function of the temperature. But the means they employed for determining the annealing constants, while accurate and dependable, is not readily adaptable to use in the ordinary laboratory, nor are specimens of glass always available in a form that permits their method to be conveniently used. For this reason it was thought that a modification of their apparatus which has been found useful in this laboratory might be of interest to others.

II. Modified Apparatus

The apparatus is shown in Fig. 1. Light from a suitable source is polarized by reflection from a black glass surface. It then passes consecutively through the glass sample in the furnace, an objective lens, a calibrated quartz wedge, the eyepiece, and a nicol prism. The quartz wedge is graduated in such a manner that the birefringence due to the strain set up in the glass may be easily measured quantitatively. The objective lens is

[1] Presented at the Annual Meeting, American Ceramic Society, Cleveland, Ohio, February, 1931 (Glass Division). Received June 12, 1931.

[2] *Jour. Franklin Inst.*, **190**, 597–631, 835–70 (1920).

[3] F. Twyman, *Jour. Soc. Glass Tech.*, **1**, 62 (1917).

focused upon the specimen, and in conjunction with the eyepiece gives an enlarged view of the glass under test.

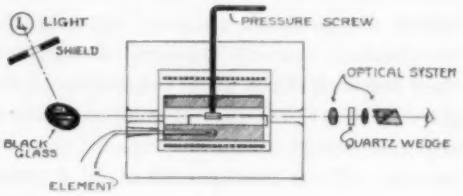


FIG. 1.

The temperature of the specimen may be maintained at a constant level by the use of an automatic temperature controlled electric furnace. Uniformity of temperature in the specimen is obtained by means of the heavy iron cylinder, which also carries the reaction of the pressure screw. The iron carrier holds the sample so that it is always in the same position under the screw.

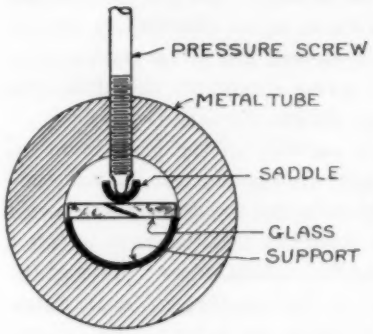
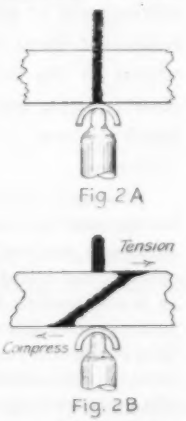


FIG. 2.

Figure 2 shows a piece of glass ready for testing as seen by looking into the furnace. A view through the eyepiece inverts the image so that an unstrained sample appears as shown in Fig. 2A. The pressure screw is on the bottom and a black band extends vertically across the field when the specimen contains no strain.

Pressure from the screw sets up a bending moment in the glass, resulting in compression stresses on the screw side and tension stresses on the opposite side. The effect of these stresses is to displace that portion of the black band seen through the specimen so that it assumes an angle as shown in Fig. 2B. The amount of horizontal displacement of the black band is assumed to be proportional to the stress.[4]



FIGS. 2A AND 2B.

For some purposes it is desirable to replace the threaded rod with a plain rod fitted with a pan to hold weights. By this means, together with measurements of the dimensions of the glass plate and the distance between the supports, the birefringence corresponding to a definite stress in mechanical units may be readily calculated. For determining the annealing constants of a glass such data are seldom required.

[4] This assumption undoubtedly holds below the elastic limit but under certain conditions of viscous flow the experiments indicate a lack of rigid adherence to this assumption.

(1) Manipulation Before measurements are started, the temperature of the furnace is raised rapidly to a convenient point within the probable range of experiment, and the rheostat or automatic temperature control adjusted to maintain this temperature. The rod is then screwed down until the indicated stress along the lower edge of the glass is about 200 mμ. The time required for the strain to be reduced to any convenient minimum, *e.g.*, 50 mμ, is taken. The temperature of the furnace is then changed 20 or 30 degrees and the process repeated. In about two hours or less, four or five points may be determined which permit the evaluation of the annealing constants.

In the manipulation of the apparatus it has been noted that starting with a new sample, the first few readings show more rapid release of strain than the rest of the curve indicates. This is in all probability due to irregularities in the contact between the glass and the metal parts. Viscous flow after a few adjustments of the screw eliminates this difficulty. In taking readings, the first few results are always discarded.

Advantage is taken of the fact that the mobility of the glass is an exponential function of the temperature, and time is plotted against temperature on semilogarithmic paper, with time on the logarithmic scale and temperature on the equally spaced divisions. The points lie on a straight line, the slope of which depends on the variation in mobility of the glass with temperature, while the intercept on the temperature scale determines the datum level or temperature at which the glass would become annealed in one minute.

It is to be noted that the strain interval measured is in general between 200mμ and 50mμ. The time required for this amount of reduction in birefringence at any temperature, is much less than the time required for a reduction from 50mμ to 5mμ, which Adams and Williamson used as a definition of the annealing time. This permits readings to be taken in a shorter time, but without undue error in determining the actual amount of birefringence.

AUTHORS' NOTE: In their original paper Adams and Williamson used the symbol μμ for the unit "millimicron" or 10^{-7} cm. In this laboratory we use the same symbol and same unit and our paper as originally written used this symbol and unit. It has been called to our attention by the Editorial Committee of the Glass Division that the symbol μμ is now used to designate *micro-microns* while the symbol mμ should properly be used to designate *millimicrons*. In order to conform to editorial standards, the symbols have been changed throughout this paper to read mμ instead of μμ, and one mμ is to be taken to be the equivalent of 10^{-7} cm. or 10 Ångström units. We are willing to conform to the editorial standards, but confess that we are not in sympathy with the change, and find it a little confusing. Moreover, so far as we can find, there is still considerable difference of opinion and confusion on this subject, and we hereby contribute to the confusion by using a different symbol than was used in the work of Adams and Williamson, which work we have repeatedly quoted and for which we have a very high regard.

For accurate measurements of small amounts of birefringence well polished surfaces would be required on the samples, and the wedge would need to be a more sensitive one, or else a sample giving a much longer optical path would be required. None of these changes was desirable, as it was required that the method be applicable to fairly small pieces of glass that could be cut from articles of blown or pressed ware, or from a piece of sheet glass. Nevertheless, it will be evident that it is very easy by this method to determine the annealing constants according to the requirements laid down by Adams and Williamson.

III. Time Required for Release of Stress

It was pointed out by Adams and Williamson that within reasonable limitations the time required for the release of stress in a glass at any temperature is defined by the following equation:

$$\frac{1}{\Delta_F} - \frac{1}{\Delta_0} = At \tag{1}$$

where Δ_0 is the birefringence due to the initial stress, when time is zero, and Δ_F is the birefringence after time, t. The quantity A was called the annealing constant, and as values of initial and final stresses 50mμ and 5mμ, respectively, were taken. Thus, when these constants are put into the equation it becomes

$$A = \frac{0.18}{t'} \tag{2}$$

Similarly, if at the same temperature the initial and final stresses are taken as 200mμ and 50mμ, and time is taken as t'', equation (1) becomes

$$\frac{1}{50} - \frac{1}{200} = At'' \tag{3}$$

or

$$A = \frac{0.015}{t''} \tag{4}$$

Consequently $t' = 12t''$, and the results given by equation (2) corresponding to the data of Adams and Williamson can be obtained from measurements of time taken while the stress is reduced from 200mμ to 50mμ by multiplying the times found by 12.

IV. The Annealing Constant

The constant A is naturally calculated by dividing the "birefringence reciprocal difference," which is called D, by the time elapsed. An actual series of measurements on a piece of glass cut from a lamp shade gave the data in Table I.

V. Softening Temperature

The values of A may be plotted against temperatures on semilogarithmic paper in place of plotting the elapsed time, thereby permitting evaluation of the constant, M_1 and M_2 in the Adams and Williamson equation for the variation of the annealing constant with temperature. This equation

$$\text{Log } A = M_1 \Theta - M_2 \qquad (5)$$

is that of a straight line when semilogarithmic paper is used. The ratio M_2/M_1 may be called the softening temperature of the glass, and the slope

TABLE I

Temperature	Time	Stress in mμ per cm. Initial	Final	D	$\frac{D}{t} = A$
450°	119.1′	200	50	0.0150	12.6×10^7
475°	25.0′	220	45	0.0177	70.8
500°	14.2′	200	45	0.0172	316.0

of the line, or M_1, may be used as a measure of the change in mobility of the glass with change in temperature in the annealing range. Thus lead glasses or glasses which have a longer working range than the harder lime glasses, have in general a higher value of M_1.

VI. The Glass Sample

The criticism might well be made that there is no essential difference between the original method and that advocated here, except the use of mechanical means of introducing the strain. Nevertheless, the fact remains that it has been found quite practical by this method to obtain accurate data on comparatively small pieces of glass in a relatively short time.

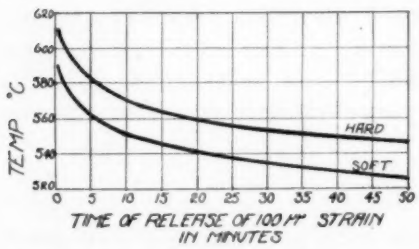


FIG. 3.—The symbol μμ should read mμ. See authors' note, p. 822.

The specimens used were of small size, approximately 1 inch long, $^1/_2$ inch wide, and $^1/_8$ to $^1/_4$ inch thick. In general, they were ordinary types of industrial glass and therefore more or less cordy and irregular. Some of the samples were rough-ground from irregular chunks of glass.

It is necessary to polish the two surfaces that will be at right angles to the path of light rays, but the quality of the polish does not need to be particularly good. If the sample is properly prepared by grinding with a fine grade of silicon carbide, the polish can be satisfactorily done by hand rubbing for a few minutes with rouge and a small piece of felt.

The dimensions of the specimen need not be adhered to with great accuracy. The experiments in this study indicated no variation due to thickness, but cords, when heavy, caused a difference as great as seven degrees in results for the same glass.

VII. Typical Data Curves

Typical curves for a hard and a soft type of window glass are shown in Fig. 3, and are replotted on semilogarithmic paper in Fig. 4. A curve giving the time of release of strain at constant temperature is shown in Fig. 5. The values of A for this curve were determined by means of equation (1). The dotted curve was obtained by plotting a constant average value of A. The differences between these curves shown in Fig. 5, appeared in all of the curves plotted by the authors, and indicate a slight deviation from the computed result, but this difference is so small that it is within the experimental error.

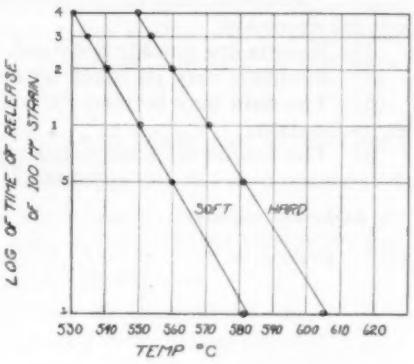


FIG. 4.—The symbol $\mu\mu$ should read mμ. See authors' note, p. 822.

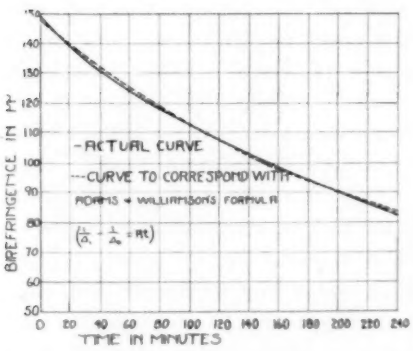


FIG. 5.—The symbol $\mu\mu$ should read mμ. See authors' note, p. 822.

VIII. Conclusions

(1) Use of Apparatus for Control

The apparatus described might prove useful in industrial work, not only in determining annealing data but also for purposes of control similar to the use of the softening point method described by Littleton.[5] Cases often arise where there is difficulty in preparing suitable thin rods of uniform cross-section such as are demanded for softening point measurements. Moreover, a number of the commercial glasses undergo surface devitrification when reworked in the flame. In such cases this apparatus has been found to be a suitable substitute for Littleton's method.

In general, the curves obtained with this apparatus and by Littleton's method are related by a small temperature difference, which is fairly constant for glasses of different hardness.

[5] J. T. Littleton, *Jour. Amer. Ceram. Soc.*, **10**, 259–63 (1927).

(2) Advantages The advantages of the optical method described here are as follows:

(1) The samples are small and easily prepared.
(2) Specimens may be preserved and used for checking as often as may be necessary.
(3) Results are quickly obtained.
(4) Readings may be taken by an observer with but little training.
(5) The data may be used for control purposes in place of other softening point data.
(6) The results are concordant regardless of the size of the specimen or the characteristics of the apparatus.

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STUDIES ON THE ETCHING OF GLASS[1]

By W. S. Kahlson

ABSTRACT

This paper discusses the factors governing the reaction silica-fluorine. The chemical nature of the reactions involved in the etching of glass are described in detail in conjunction with a crystallographic analysis. The behavior of etching solution toward glasses of varying composition is described.

I. Factors Governing the Reaction between Glass and Hydrofluoric Acid

Etching generally involves reactions which first form silicon tetrafluoride, a gas which greedily absorbs water forming hydrofluosilicic acid. This silicic acid in turn hydrolyzes into the hydrate of silicon.

The simplest reagent for glass etching is hydrofluoric acid. If a definite amount of hydrofluoric acid is allowed to be in contact with a glass surface, glass will be dissolved until all the hydrofluoric acid has been converted into hydrofluosilicic acid. The reaction rate is a function of hydrofluoric acid concentration and temperature. The glass surface remains transparent.

If concentrated solutions are employed (above 25% HF) the surface loses its smooth appearance, because the diffusion of the reaction products is slow, and hence uniform concentration of acid on the glass surface is not maintained. There is no sign of a mat etch and there is no evidence of any crystalline formations. The formations on the glass surface seen under the microscope after washing the surface with water are nothing but glass. There is nothing added and there is no selective removal of any constituent of the glass.

Certain striations are visible on the surface as well as a fine pitting (Fig. 1) caused by the influence of the movements of the fine precipitate upon the concentration of active acid.

By the addition of a strong acid such as sulphuric acid, the hydrolysis of the hydrofluosilicic acid is retarded and a more uniform solution of the glass is obtained. This finds practical use in so-called acid polishing.

II. Effect of Ammonium Fluoride

To produce a mat etch, addition of ammonium fluoride and sodium fluoride to the hydrofluoric acid is necessary. The addition of no other substances will produce so fine an etch. Optically in transmitted light, their effects are good diffusion and a pleasing pearl-like finish.

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[1] Presented at the Annual Meeting, American Ceramic Society, Cleveland, Ohio, February, 1931 (Glass Division). Received March 7, 1931.

(1) Physical Aspects Soda-lime glass bulbs were quickly flushed with various etching solutions and the weight of glass removed in a certain length of time was determined. The surface area (179 sq. cm.) of glass exposed to the acid is the same for each bulb as also are the temperature and the amount of available fluorine. The amount of available fluorine is 210 milligrams which is capable of dissolving about 140 milligrams of glass.

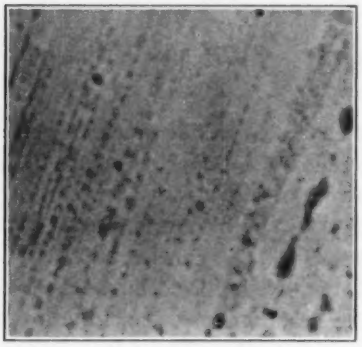

FIG. 1.—Magnification 1100 ×.

Curve *a* (Fig. 2) represents an aqueous solution of hydrofluoric acid and 5% ammonium fluoride. The curve approaches asymptotically the value 140. In this curve dy/dx represents the rate of reaction and can be graphically determined at any point. After 20 seconds dy/dx approaches 0 and the reaction is chemically complete.

Curve *b* (Fig. 2) represents an aqueous solution of hydrofluoric acid. After 50 seconds dy/dx is still of considerable magnitude. The reaction would require about 2 minutes to go to completion.

Curve *c* (Fig. 2) represents an aqueous solution of hydrofluoric acid to which has been added a chemically inert substance. The reaction rate is now greatly reduced and several minutes would be required to carry the reaction to completion.

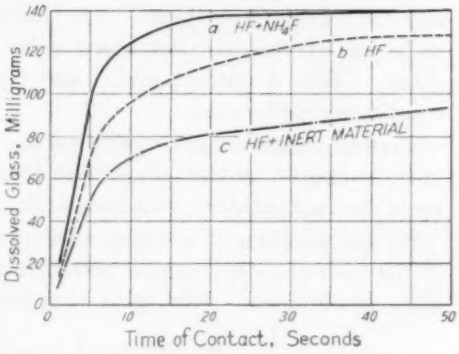

FIG. 2.—Glass dissolved by fortifying sols at constant HF.

In the presence of ammonium fluoride the acceleration of the reaction is probably due to the formation of ammonium silico-fluoride with a liberation of hydrofluoric acid. If pure hydrofluoric acid is used the formation of hydrofluosilicic acid increases the viscosity of the solution and decreases the diffusion of hydrofluoric acid to the glass surface. An addition of an inactive substance has the same effect as shown by curve *c* (Fig. 2).

In practice it is also found that the addition of a small amount of ammonium fluoride to the commercial fortifying solution gives better and more rapid results than hydrofluoric acid alone.

The total amount of glass removed by fortifying solutions depends, evidently, only on the amount of available fluorine. The reaction rate is accelerated by the presence of ammonium fluoride and is influenced by the temperature and viscosity of the solution.

The same experiment using a commercial etching solution gave results shown in curve *a* (Fig. 3). The weight of glass removed is plotted against time.

The reaction proceeds quickly at a constant reaction rate, but then stops suddenly and does not proceed further. This is an excellent confirmation of the protection theory as amplified by C. D. Spencer.[2]

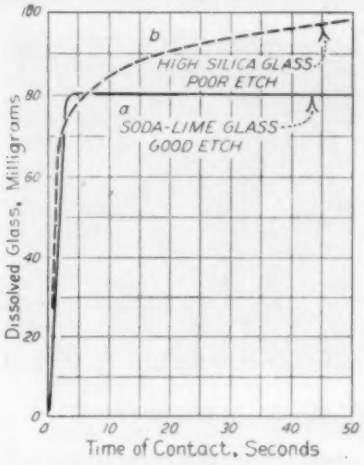

FIG. 3.—Glass dissolved by etching sols.

The amount of acid in contact with the glass surface was 3.5 grams and the amount of glass dissolved was 81 milligrams corresponding to about 8.5% of available fluorine. Analysis of the acid retained in the bulb after etching shows a diminution of available fluorine that agrees fairly well with this calculated figure.

If the acid is allowed to be in contact with the glass surface for only 0.9 second, 20 milligrams of glass will be removed but the glass will remain clear. This shows that the beginning of the reaction consists of a uniform dissolving of glass from the surface.

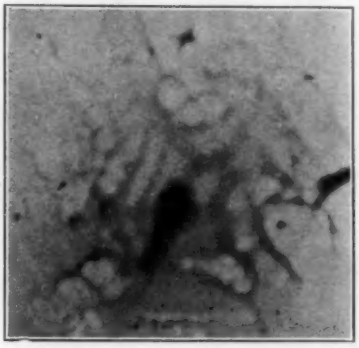

FIG. 4.—Magnification 1100 ×.

With etching solutions, an increase of the viscosity of the solution, due to sodium fluoride, will prevent the free diffusion of the reaction products into the acid. A film of hydrofluosilicic acid is therefore formed on the glass surface which reacts with the dissolved ammonium fluoride precipitating ammonium silico-fluoride with liberation of hydrofluoric acid. The liberated acid further attacks the glass at the edges of the crystals.

The effect of this liberated hydrofluoric acid is plainly noticeable on

[2] C. D. Spencer and L. Ott, "Frosting of Glass by Mixtures Containing Hydrofluoric Acid and Alkali Fluorides," *Jour. Amer. Ceram. Soc.*, **10** [6], 402–10 (1927).

crystals growing at a high rate (Fig. 4). Deep grooves or fissures in the surrounding glass may be seen at the intersection between the crystal and the glass which undoubtedly are the cause of the peculiar hemispherical depressions which appear after fortification.

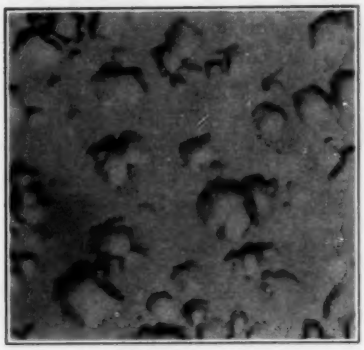

FIG. 5.—Magnification 1100 ×.

(2) Crystal Formation Ammonium silico-fluoride is polymorphous and crystallizes in hexagonal or cubic form. According to Groth[3] the transition point in an aqueous solution is about 32°C. In a solution of complex nature both hexagonal plates and octahedons may be noticed because temperature is not the only controlling factor.

In a solution of low ammonia concentration, large hexagonal crystals are formed. The hexagonal modification is, however, the least stable. The crystal does not grow to perfection but is generally split and then leaves the glass. Such a crystal is shown in Fig. 4 with perfect octahedrons surrounding it. In a poor etch, where slow seeding of the crystals allows them to grow to considerable size, the hexagonal crystal is prevalent.

To produce a good fine etch, the seeding of the crystals must be rapid. This is accomplished through proper viscosity and correct concentration of hydrofluoric acid and ammonium fluoride. A great number of small crystals practically all cubic (octahedrons and tetrahedrons) are then formed.

Figure 5 shows proper seeding on a soda-lime glass and Fig. 6 shows the surface after completion of the reaction. Only a slight increase in size is then required to cover the surface completely and to stop the reaction.

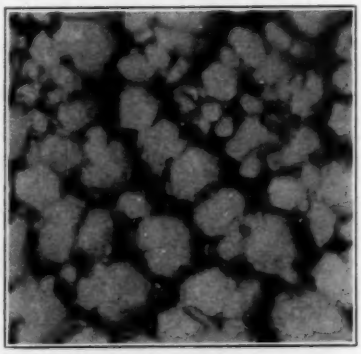

FIG. 6.—Magnification 1100 ×.

Due to the nonuniformity of the solution and the stresses to which the crystals are subjected, considerable distortion and twinning occurs. Many crystals, perhaps all which appear to be hexagonal, are two tetrahedric crystals superimposed with their planes of symmetry at 60°. The same phenomenon occurs with the octahedric crystals which then appear to be eight-sided. The octahedrons are twinned with their planes of symmetry

[3] P. Groth, Physikalische Krystallographic, Munich.

at 45°. If the corner of one crystal then falls on the geometric center of the other one, the combination appears to be five-sided. All these crystals probably are ammonium silico-fluoride.

(3) Function of Sodium Fluoride All evidence indicates that sodium does not enter into the reaction, which can be expected from the low solubility of the sodium fluoride in the solution. The purpose of the sodium fluoride is to increase the viscosity of the solution and depress the solubility of the ammonium silico-fluoride. Other chemically inert materials, such as barium sulphate and wood flour, will perform the same function.

A solution of hydrofluoric acid and sodium fluoride will not produce a mat etch or even crystals of microscopic size, while a solution of hydrofluoric acid saturated with ammonium fluoride will give a fairly opaque mat etch with well-developed crystals.

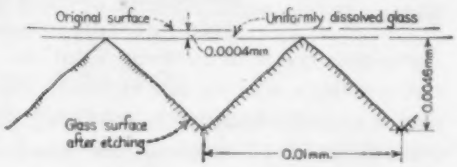

FIG. 7.—Perfect etch on soda-lime glass. Magnification 3000 ×.

III. Dimensions and Crystal Size

Having the weight of glass removed from the surface and the lateral dimensions of the crystals, it is possible to construct a geometric picture of the etch contour. This is shown in Fig. 7. The crystals are all pyramidal. The calculations used to determine the linear dimensions perpendicular to the surface do not involve any approximations.

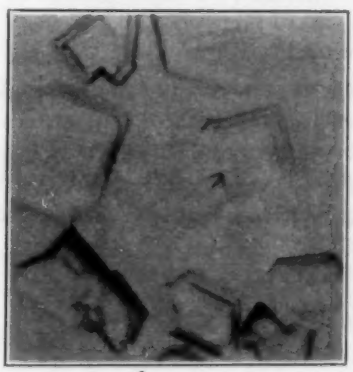

FIG. 8.—Magnification 1100 ×.

When the etching solution first comes in contact with the glass, a certain amount of glass is uniformly dissolved. The thickness of this dissolved glass film is 4×10^{-4} mm. The depth of the crevice between two peaks is 46×10^{-4} mm. The number of crystals per square centimeter is 1,100,000.

These calculated dimensions agree well with the height of between 4μ and 8μ given by C. D. Spencer.[2]

It is possible to check these dimensions by calculating the amount of ground iron oxide that is required to fill these crevices. The calculated amount is 30 milligrams and the amount determined by weighing is 27 milligrams.

IV. The Behavior of Etching Solutions toward Glass of Various Compositions

The behavior of an etching solution differs with the composition of the glasses. An etching solution that in two seconds will produce a perfect mat etch on a soda-lime glass may not have any visible effect after several minutes on a borosilicate glass, in spite of the fact that a great amount of glass has been dissolved from the surface.

(1) Borosilicate Glass The curve of dissolved glass plotted against time for a borosilicate glass (Fig. 3, curve *b*) does not ascend as steeply as with soda-lime glass, but resembles more the curve obtained with fortifying solutions. The correct balance between the two reactions, solution and crystallization, is not maintained and the diffusion of reaction products is too rapid. Increasing the ammonium fluoride concentration will increase the tendency toward crystallization. This, however, cannot be done without also increasing the hydrofluoric acid concentration as the solubility of ammonium fluoride is a function of the HF-acidity.[4]

(2) Lead Glass Lead glass, which generally contains less silica than soda-lime glass is easy to etch satisfactorily in a few seconds.

(3) High Silica Glass Figure 8 shows the seeding of ammonium silico-fluoride crystals on a glass containing a high percentage of silica and which in other respects also varies considerably in composition from a soda-lime glass. The composition of the glass has no influence on the shape of the crystals formed, as can be readily seen by comparison with Fig. 5.

V. No Universal Solution Probable

Although efforts have been made to devise an etching solution that would satisfactorily etch any kind of glass, it has met with but little success. The chemical nature of the processes involved, the details of which we have endeavored to explain from the experimental evidence offered, supports our opinion that any such universal etching solution is rather problematical.

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[4] This is probably the reason, rather against expectations, why it is difficult to produce in a short time a good mat etch on glasses containing a high percentage of silica.

THE WEATHERING AND IRIDESCENCE OF SOME ANCIENT ROMAN GLASS FOUND IN CYPRUS[1]

By. A. W. Laubengayer

ABSTRACT

Samples of ancient Roman glass taken from burial vaults on the Island of Cyprus have been examined. Analysis shows the glass to be of the soda-lime type characteristic of that period. The heavy incrustation produced by weathering has been studied spectroscopically and microscopically and is shown to consist, for the most part, of hydrated silica, formed by the slow hydrolytic decomposition of the glass. The beautiful iridescence exhibited by the glass is due to the selective destructive interference of light by the thin films of transparent incrustation on the surface of the glass.

I. Source of the Glass

The glass described is of Roman origin of the second or third century A. D. and was found on the Island of Cyprus. In certain parts of the Island the bed rock is only a foot or so under the surface. In ancient times persons of prominence were buried in tombs dug in this rock. A shaft about three feet square was sunk some six feet deep and then a low horizontal passage was hollowed out leading to the burial vault proper. There the body was placed, surrounded with articles calculated to aid and comfort the deceased in the future life, and the tomb was sealed.

The climate of Cyprus is rainy and as time went on the abundant surface water washed silt into the tombs, in some cases entirely filling them and burying the objects placed there. The entrance shafts also filled up and were obliterated. When one of these tombs is discovered excavation must be accomplished very carefully for many of the articles found buried there have been corroded until they are extremely fragile. They usually include coins, jewelry, glass, pottery, and bronze mirrors. The glass, which has been embedded in the moist silt for centuries, has undergone a great deal of weathering and exhibits beautiful iridescence. Sometimes glass vessels are found placed in niches high up on the walls where the silt has not come in contact with them. These pieces usually show little weathering or iridescence.

A friend collected some of the buried glass, and fragments of tear jugs and ointment jars have been studied.

II. Examination and Analysis

The glass is covered with a layer of reddish dirt, the remains of the silt in which it was embedded. Under this dirt is an incrustation about three tenths of a millimeter thick composed of a white flaky material produced by the decay of the glass. It is easily dislodged and crumbled. The glass thus uncovered has a pebbled surface, somewhat pitted, and a slightly green

[1] Presented at the Annual Meeting, American Ceramic Society, Cleveland, Ohio, February, 1931 (Glass Division). Received May 12, 1931.

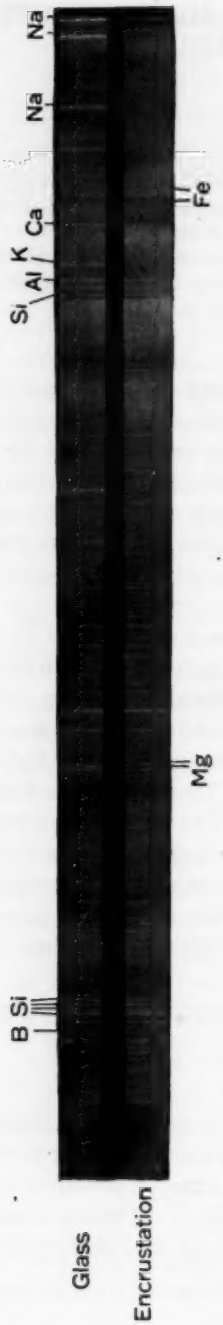

FIG. 1.

color due to iron; it is relatively free from bubbles and is gracefully shaped. It is extremely brittle, easily powdered, apparently without conchoidal fracture surfaces. Microscopic examination has failed to show any detectable crystallization. The glass has a refractive index of 1.52.

Samples of the glass and of the incrustation were subjected to spectroscopic analysis.[2] Figure 1 shows the arc emission spectra obtained, the prominent lines of the elements occurring in appreciable amounts being indicated. The glass is found to contain silicon, sodium, and calcium as the main constituents, together with small amounts of aluminum, magnesium, potassium, boron, iron, and manganese. In the spectrum for the incrustation the lines for sodium and potassium have almost entirely disappeared, while only faint lines for calcium and boron are visible. On the other hand, the lines for silicon are still very strong and those for aluminum, magnesium, iron, and manganese have become stronger. This would indicate that the incrustation is composed, for the most part, of silica, with more aluminum, magnesium, iron, and manganese than there is in the original glass, and that practically no sodium, potassium, calcium, or boron is present. The glass is a soda-lime glass quite similar in composition to the Roman glasses of the first and second centuries A. D. described by Neumann.[3]

The incrustation, examined under the microscope, was found to be built up of exceedingly thin plates covered by a network of cracks, presenting the appearance of a jelly which has been formed in thin layers and then has dried and cracked. This material is transparent and isotropic and has a refractive index of about 1.477. It was found to contain considerable water of hydration, and contracted and curled up when dehydrated. This incrustation, therefore, must consist mainly of hydrated silica.

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[2] Through the coöperation of Professor J. Papish.

[3] Neumann, *Z. angew. Chem.*, **38**, 857 (1925).

III. Nature of the Weathering Process

The glass, embedded in the moist silt, underwent hydrolytic decomposition due to the action of the ground water that undoubtedly contained considerable amounts of carbon dioxide. The soluble substances formed were leached away. The greater portion of the silica was precipitated as hydrated amorphous silica, and, together with the other insoluble materials

TABLE I

ANALYSIS OF GLASS*

	(%)		(%)
SiO_2	66.51	MgO	0.86
Al_2O_3	2.45	Na_2O	17.53
Fe_2O_3	0.48	K_2O	1.30
CaO	9.73		

* By Hillebrand and Lundell method from Applied Inorganic Analysis, 1929, p. 851, J. Wiley & Sons.

present, collected to form the incrustation. This incrustation, gradually accumulated and held in place by the silt, was very porous and allowed the easy access of more water to the glass surface for further hydrolytic attack which continued slowly through the centuries.

Since the conditions outlined for the weathering of this glass are quite similar to the weathering conditions for siliceous minerals in contact with soil, this study serves to throw some light upon the nature and rate of such natural weathering of rock.

IV. Iridescence and Its Cause

The observations throw some light upon the probable mechanism of the weathering. The nature and the cause of the iridescence are readily seen if the surface is studied under the microscope using the methods described by Mason[4] in his study of the iridescence of feathers.

The weathering of the glass produces a pebbled surface which is covered by the thin films of transparent material resulting from decay. There being no pigment present, the brilliant colors observed cannot be due to such a cause. It can easily be shown that the color is due to interference effects caused by the thin films.

When viewed by reflected light the incident white light may be reflected from either the top or the bottom surfaces of the film. The part of the light which has traveled through the film and has been reflected from the lower surface back through the film again is retarded and certain wave-lengths will reinforce the like ones reflected from the top surface while other wave-lengths will be out of phase and destructive interference will occur. The result is that the reflected light observed is colored. When the in-

[4] Mason, *Jour. Phys. Chem.*, **27**, 401 (1923).

cident angle is changed the distance traveled by the light through the film changes and different wave-lengths of light get out of phase and the color changes. This iridescence, or change of color with change of position, is characteristic of colors produced by thin films.

The iridescent coloring of this glass, therefore, is quite similar to that produced when a drop of oil is allowed to spread on a wet pavement or that observed in soap bubbles or as the temper color on metals.

In this ancient Roman glass the iridescence is greatly enhanced by the network of curved surfaces present on the film. Also, the presence of several layers or multiple films intensifies the color. The iridescence may be observed most favorably if a black or dark colored background is provided to cut off transmitted light which would tend to dilute the interference colors. Hence the most beautiful iridescence is shown by those pieces of glass which are colored or which have dirt or other dark colored material on one side.

V. Summary

The weathering suffered by ancient Roman glass buried for some 1800 years in moist silt has been shown to be that which might be expected if slow hydrolytic attack with the leaching away of the soluble products and the accumulation of the insoluble material has taken place.

The iridescence is due to the interference effects produced by the thin films of incrustation on the surface of the glass.

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X-RAY AND MICROSCOPIC STUDIES OF SILICATE MELTS CONTAINING ZrO_2[1]

By Helen Blair Barlett

ABSTRACT

Silicate melts containing ZrO_2 were examined by means of the X-ray and the microscope to establish the form of crystallization of the zirconium compounds under various conditions of temperature and composition. The effect of certain fluxes on these compounds was also determined.

I. Introduction

The investigations of Ruff and Ebert[2] and Cohn and Tolksdorf[3] have shown that ZrO_2 may exist in more than one allotropic form. Davey[4] and Yardley[5] have also studied the crystal structure of this oxide. Cohn[6] and Merritt[7] have investigated the expansion properties of zirconium bodies. The changes in density, color, and refractive indices of zircons under different heat treatments are reported by Eppler[8] in considerable detail. Matignon[9] has studied the effect of high temperatures on certain refractory substances, and states that zircon apparently dissociates at 1800°C into ZrO_2 and silica vapor, the latter evident in the abundant fumes given off. This, with the work of Washburn and Libman[10] on the zirconia–silica system, seems to be practically all that has been reported on the fusion relations of the silicate.

The present objective is to establish whether or not zircon or zirconium oxide may be incorporated in a ceramic body indiscriminately with the same final result.

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[1] Presented at the Annual Meeting, American Ceramic Society, Cleveland, Ohio, February, 1931 (White Wares Division). Revised copy received July 16, 1931.

[2] Ruff and Ebert, "Die Formen des Zirkondioxyds," *Z. anorg. allgem. Chem.*, **180**, 19–41 (1929).

[3] Cohn and Tolksdorf, "Die Formen des Zirkondioxyds in Abhangigkeit von der Vorbehandlung," *Z. physik. Chem.*, Abt. B, Bd. 8, Heft. 5.

[4] W. P. Davey, "Crystal Structure of Zirconium Oxide," *Phys. Rev.*, **27**, 798 (1926).

[5] K. Yardley, "The Structure of Baddeleyite and of Prepared Zirconia," *Mineral. Mag.*, **21**, 169–75 (1928).

[6] Willi M. Cohn, "Über das Ausdehnungsverhalten verschieden aufbereiteter Zirkondioxyd in Temperaturgebeit 0–1400°C," *Keram. Rund.*, **38**, Nos. 48–52 (1930).

[7] G. E. Merritt, "Thermal Expansion of Some Fused Oxides Used as Refractories," *Jour. Amer. Electrochem. Soc.*, **50**, 164 (1926).

[8] W. F. Eppler, "Über das optische Verhalten, etc.," *Neues Jahrb. Mineral. Geol.*, Usw. Beil.-Bd. A, **55**, 401–87 (1927).

[9] de M. C. Matignon, "Action des temperatures elevées sur quelques substances refractaires," Académie des Sciences, Dec. 10, 1923, pp. 1290–93.

[10] E. W. Washburn and E. E. Libman, "An Approximate Determination of the Melting Point Diagram of the System Zirconia–Silica," *Jour. Amer. Ceram. Soc.*, **3** [8], 634 (1920).

FIG. 1.—Diffraction spectra of ZrO_2 (lower) and MgO (upper). A few of the zirconia lines appear on the magnesia side.

II. Experimental

The compositions were made from commercial grades of zircon, zirconia, alumina, silica, Georgia kaolin, and fluxes, the fluxes being introduced in the form of carbonates. The proper materials were weighed out, thoroughly wet mixed in ball mills, and made into bars, which were dried and calcined. The fusions were made in a three-phase electric arc furnace. The bars were introduced into the arc and as the material fused it dropped and rolled down a trough of running water into a pan. In this way crystallization was arrested, so that the conditions at very high temperatures could be studied. Annealing was done on a 15-hour schedule, the samples being held at the high temperature for about $3^1/_2$ hours, the maximum temperature being about 1450°C. By this process the quickly cooled glasses were devitrified and conditions well below the fusion temperature of the melts could be investigated.

The samples were examined with a petrographic microscope, and finally by means of X-rays, for the fineness of crystallization and the constant association of glass made it impossible to come to definite conclusions by microscopic methods alone. The samples were ground very fine, mounted in glass tubes about 0.5 mm. in diameter and exposed to radiation of a Coolidge molybdenum-target X-ray tube. The reflections of the X-rays from the crystal particles were recorded on a photographic film as a series of lines. The positions of these lines and their relative intensities are characteristic for each compound in the sample.

III. Results

(1) ZrO_2–SiO_2 System

Some facts about the two-component system ZrO_2–SiO_2 were first determined. Zirconium oxide, the silicate(zircon), a melt high in ZrO_2 and low in silica as well as one with equal quantities of the two oxides were studied.

X-ray photographs were made of three samples of zirconium oxide: (1) the raw material as received, (2) a sample annealed as described above, and (3) a product fused in the electric arc furnace.

In all three cases the same pattern was obtained (Fig. 1). This pattern corresponds to the monoclinic form described by Ruff and Ebert[2] and by K. Yardley.[5] No other form was discovered in this investigation. Yardley also reports only the monoclinic form of zirconia in an examination of the natural oxide baddeleyite, and of two artificially prepared samples.

Zircon ($ZrO_2 \cdot SiO_2$) was next studied (Fig. 2). Microscopic examination showed that this crystal when fused did not recrystallize in its original form but appeared to consist of a brown fibrous aggregate with a mean index of about 1.80. Closer examination, however, disclosed that it was made up of extremely minute crystals in optical continuity over considerable areas, embedded in an isotropic matrix. The crystals seemed to be biaxial and to be optically negative, while the elongation of the pseudo-fibrous crystals was positive; their refractive index was very high. Thus, it appeared that the zircon had dissociated into another crystal phase and a glass. This same structure was observed in many other fairly high zirconia melts. The mean refractive index of the aggregates varied considerably, but was usually 1.74 to 1.80. Because of these conditions the X-ray seemed to be the only method for definitely establishing the identity of this new phase. Accordingly a diffraction pattern was obtained for the fused zircon mass, which was found to correspond to that of monoclinic zirconium oxide (Fig. 3). The zircon had dissociated into ZrO_2 and a high silica glass. A sample of zircon fused by the company from which it was obtained and apparently under somewhat different conditions than obtained

FIG. 2.—Powder photograph of zircon (lower) with a comparison photograph of MgO (upper).

FIG. 3.—Powder photograph of fused zircon (lower). MgO photograph for comparison (upper).

in this laboratory, disclosed well-developed zirconia crystals embedded in a glass the low index of which indicated that it was almost pure silica. An X-ray photograph of this sample showed one strong line not observable on any of the other films, which line is very characteristic of cristobalite. It is probable that this high temperature form of silica had been developed.

The electrically fused zircon prepared by the writer was then annealed on the schedule outlined above. As in the case of all other melts in which this brown fibrous crystallization occurred, this annealing treatment almost completely removed both the structural character and the color, evidently by a growth of crystals from almost sub-microscopic size to a size readily resolvable by the microscope. It seemed now to be composed of zircon grains (as indicated by refractive index and positive sign) in which were enclosed extremely minute crystals of the oxide. This was substantiated by the X-ray film (Fig. 4), which showed the zircon pattern with a few of the strongest oxide lines appearing with greatly diminished intensity, indicating that the latter was present in comparatively small quantity. Zircon, then, when subjected to high temperatures dissociates into ZrO_2 and a high silica glass, and under certain conditions into cristobalite; but if it is quickly cooled so that the crystals have little time to grow the two oxides are left in such a condition that at a comparatively low annealing temperature they reunite to form the silicate. There is doubtless some volatilization of silica, which accounts for the residual zirconia. Probably also those crystals which have grown to considerable size do not enter into the reaction at that temperature. The dissociation starts as low as 1450°C, because after the unfused zircon has undergone the annealing process it shows a small percentage of the characteristic brown fibrous crystallization and an X-ray film shows a few weak ZrO_2 lines.

As a further step in the investigation of the two-component system, a melt made of 50% zircon and 50% zirconium oxide was prepared and found to consist of zirconia crystals and glass. X-ray examination also revealed the oxide. The refractive index of the glass indicated that it was very low in ZrO_2. No further study was made of this melt.

A very interesting feature of a 50% zirconia, 50% silica melt is that it is apparently composed of two immiscible liquids, one of which has devitrified (Fig. 5). The dark areas are the devitrified liquid and are brown as is fused zircon; the intermediate clear areas are glass. The crystal is ZrO_2 according to X-ray analysis. When this product is annealed the clear glass becomes turbid, apparently by precipitation of ZrO_2. An X-ray analysis reveals that both zircon and the oxide are present in the annealed sample, the former predominating as evidenced by the fact that some of the oxide lines are missing.

(2) ZrO_2–Al_2O_3–SiO_2 System To determine the nature of crystallization of zirconium compounds in the three-component system, zirconia–alumina–silica, a melt containing 11% kaolin anhydride and 89% zircon was made. The same brown fibrous crystallization observed in fused zircon was obtained, and the X-ray pattern corresponded to ZrO_2. Annealing resulted in the formation of zirconium silicate with some residual oxide.

It seems likely that any melt in which occurs the characteristic brown fibrous-appearing crystallization, with negative sign and positive elongation, will yield zircon when annealed or fired as an ingredient in an ordinary ceramic body. In most cases some of the oxide crystals will have grown to such a size that they will be unaffected by this further treatment.

In fused compositions high in alumina where

FIG. 4.—Powder photograph of zircon, fused and subsequently annealed (upper). Comparison photograph of MgO (lower).

mullite is the chief crystal phase, the zirconium crystals seem to have been precipitated between the mullite fibers. The X-ray failed to reveal their presence, however, in a composition corresponding to 10% ZrO_2 and 90% mullite.

(3) System ZrO_2–Al_2O_3–SiO_2 Plus Flux

Several compositions were examined to discover the effect of fluxes on the form of zirconium crystallization. In the cases studied, the product as it came from the arc furnace was entirely glass,

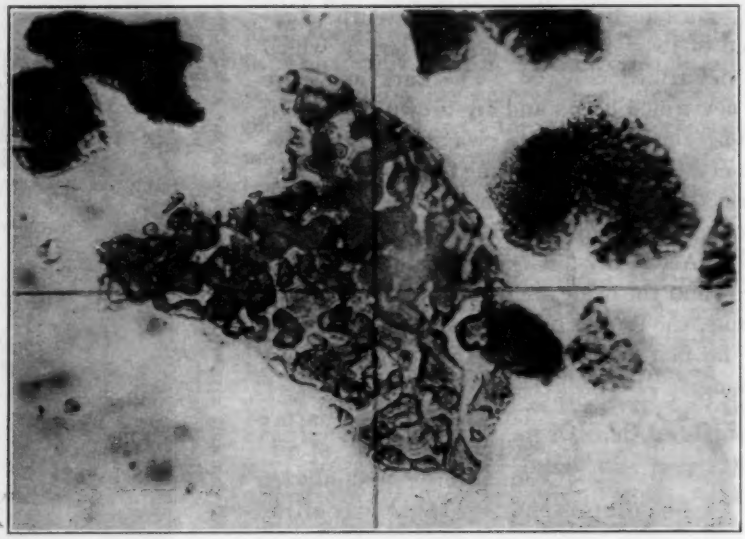

FIG. 5.—Photomicrograph of a grain showing immiscibility in a zirconia-silica melt. Dark areas are the liquid that has devitrified during cooling.

so annealing was necessary to produce crystallization. The compositions of the melts are given in the following table together with the kind of zirconium crystals present.

Flux	Al_2O_3	SiO_2	ZrO_2	Zirconium Crystals
MgO 11.2	33.1	39.0	16.7	Zircon
CaO 11.2	33.1	39.0	16.7	Zircon
Li_2O 2.7	38.9	39.0	19.4	Zirconia
Li_2O 3.8	38.5	38.3	19.4	Zirconia

It is seen that with MgO as a flux zircon crystallizes out, as is the case with CaO. When Li_2O is used, however, zirconia and not zircon is formed, although the compositions are much the same, only the flux being different. Lithia apparently has a greater affinity for silica than has zirconia, and despite the fact that the zirconium minerals crystallize out first they are

unable to appropriate any of the silica from the Li_2O. Lime and magnesia do not have such a tenacious hold on the silica, consequently zircon is formed.

It was observed that it is not mullite, as one might expect with so high a silica content, but corundum that appears in the lithia melts, so that all the silica is left for the lithium aluminum silicate, which is the last to crystallize. Many other melts were studied microscopically, which corroborated the preceding results, but only those are given of which X-ray analysis has also been made.

IV. Summary and Conclusions

(1) Only the monoclinic form of zirconia is found in this investigation.
(2) Zircon when fused dissociates into ZrO_2 and a high silica glass. The final product is zircon when the melt is annealed at about 1400°C.
(3) Cristobalite sometimes develops in the fusion of zircon.
(4) Zircon crystallizes from melts containing MgO and CaO.
(5) ZrO_2, and not zircon, crystallizes from melts containing Li_2O.

The flux determines whether zirconium oxide or silicate is the final product in compositions whose silica content is less than that of kaolin anhydride, regardless of how the zirconium is introduced. This applies only in compositions where the material is fused. Zircon introduced as such into a ceramic body would be altered very little in firing and the oxide would probably be affected even less. The action of the flux would depend upon whether or not it had been previously fused with the zirconium mass. Introducing it separately into the body would result in comparatively little reaction with the zirconium constituent.

The incorporation of fused zircon in a body might also introduce cristobalite. If quickly cooled, however, it is unlikely that cristobalite will develop and the final product will be essentially zircon. The properties of a body containing zircon in this condition, however, might be considerably different than if the raw material had been used.

AC Spark Plug Co.
Flint, Michigan

X-RAY DIFFRACTION EXAMINATION OF HIGH-FIRED PORCELAIN[1]

By E. J. Martin,[2] D. W. Faulkner,[2] and A. H. Fessler[3]

ABSTRACT

An X-ray diffraction examination was made of high-fired porcelain to determine if strains, differences in composition, or density of the crystalline phases could be detected. Both inherent and superimposed strains were studied. Although very small changes in the diffraction pattern of porcelain under superimposed strains have been recorded, not enough data have been obtained to state definitely whether inherent strains can be detected by this method. Details of X-ray equipment and procedure are given.

I. Introduction

Considerable variation in values is encountered in the physical testing of porcelain even though the test samples are identically composed and processed. Differences in densities or composition, or the presence of inherent strains, might be responsible for these erratic physical test values. Microscopic examination has not disclosed any explanation for such differences. An X-ray diffraction examination seemed to offer the most promising possibilities of solution.

II. Diffraction Methods

Crystals are made up of an orderly array of atoms. Information in regard to the internal arrangement of these atoms may be obtained by studying the external form, but there are always several possible internal arrangements for any given external form. It is necessary to use X-ray to determine which of the possible internal structures actually exists. There are several methods available but all use the same fundamental principle, that is, diffraction.

X-rays are similar to light but are of shorter wave-length. When these waves pass into a crystal they are scattered by the atoms and the scattered waves interfere with each other. In some directions the interference is destructive and in other directions additive.

There are a number of different methods by which crystals and crystalline aggregates may be studied with X-rays. They differ in the type of sample required, the means of defining the X-ray beam, the means of registering the diffracted beams, the analysis of the data, and the character of the resulting information. Probably the method most commonly used for problems of this kind is the so-called monochromatic pinhole method.

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[1] Presented at the Annual Meeting, American Ceramic Society, Cleveland, Ohio, February, 1931 (White Wares Division). Revised copy received September 8, 1931.

[2] General Motors Research Laboratories, Detroit, Mich.

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It may be readily applied to crystal powders or crystalline aggregates such as occur in porcelain. Registration is obtained on a film and considerable information may be obtained from the picture without involved analysis.

(1) Description of Apparatus

Figure 1 is a schematic diagram of the apparatus used. A water-cooled X-ray tube having a molybdenum target is enclosed in a cylindrical lead shield. The shield is pierced with five holes equally spaced around its circumference and in front of each hole is placed a pinhole system similar to the one shown in the diagram. The X-rays from the target of the tube are limited by two pinholes of about 0.05 inch diameter in lead disks so that a narrow beam emerges from the second pinhole. This beam strikes the sample and is diffracted. The diffracted beams are recorded on a flat photographic film, the central or undeviated beam being stopped by a small lead button in front of the film, for due to its great intensity, this beam would tend to spread out on the film giving a central spot so large as to conceal or fog part of the diffraction pattern. The button may be removed during a few minutes of the exposure if a record of the position of the central spot is desired. A zirconium oxide screen is sometimes placed in the path of the X-rays to filter out some of the wave-lengths and leave a nearly monochromatic beam.

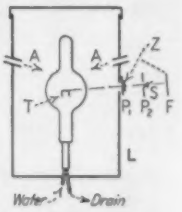

FIG. 1.—X-ray diffraction apparatus. *A*, air to cool tube. *T*, target. *L*, lead shield. *P*, pinhole. *Z*, zirconium oxide filter. *S*, sample. *F*, film.

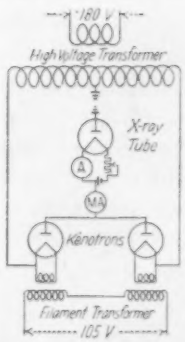

FIG. 2.—Circuit diagram for X-ray tube.

A considerable number of adjustments in the apparatus are desirable for experimental work. The distances between sample and film, between pinholes, and between the first pinhole and the tube can be readily changed. The lead disks in which the pinholes are drilled can be easily replaced with others having holes of different diameters. The axis of the two pinholes can be moved to line it up with the target. All parts can be rigidly fixed so that during long exposures there will be no relative motion. The two pinholes, sample holder, and film holder are made up as one assembled unit. This has the advantage that if the film holder is once placed perpendicular to the X-ray beam it remains so during subsequent adjustments such as lining up the pinhole axis with the target. Also, this assembly can be removed to be used in front of other X-ray tubes if desired.

The electrical circuit used with the tube is shown in Fig. 2. The potential across the transformer is 60,000 volts and across the X-ray tube 30,000 volts r. m. s. This is measured with a sphere gap and controlled by

an auto-transformer in the primary of the high-voltage transformer. Full wave rectification is obtained by using two kenotron tubes connected as shown. A filament transformer was constructed to operate on a 110-volt line and to supply 32-ampere filament current, at 9 volts, to each kenotron. The primary of this transformer is insulated from the secondary for 40,000 volts and the two secondaries are insulated from each other for 80,000 volts. The filament of the X-ray tube is heated by current from two storage batteries. These, together with the meters for measuring filament and plate currents, are insulated from ground for 30,000 volts.

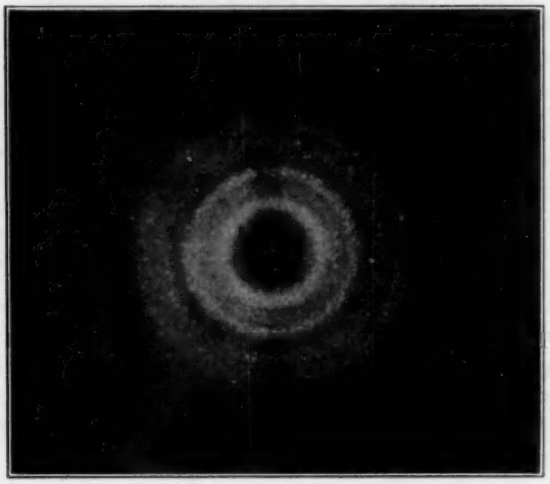

FIG. 3.—Porcelain turned shape. The peppering of small spots indicates crystal sizes larger than 10^{-3} cm., while the rings indicate crystals of the order of 10^{-6} cm.

III. Diffraction Pattern of Porcelain

(1) Crystals larger than approximately 10^{-3} cm. in size diffract a beam of X-rays according to their area interposed in the central beam, and specimens composed of them will give a pattern of separate spots distributed at random.

(2) Crystals between about 10^{-3} cm. and 10^{-6} cm. diffract beams which are individually invisible, and a specimen composed of them gives a pattern on the flat film consisting of a series of sharp concentric rings.

Samples composed of crystals smaller than approximately 10^{-6} cm. produce the same pattern of concentric rings but which broaden out as the size of the crystals decreases.

(3) Of course, there is no sharp change or borderline between these three classes; the pattern changes gradually as the size of the crystals increases or decreases from one extreme to the other. For crystals constituting parts of classes one and three, quantitative measurement of size can be made by calibrating the instrument.

Observation of the patterns of the porcelains studied indicate that there are two of the three classes of crystals present. That the first class is present is evidenced by the peppering of small diffracted spots (Fig. 3) and the third class or borderline between the second and third is present as evidenced by the concentric rings. Most of the porcelains studied, such as

the finished ware, turned shapes, fired shapes, filter-press cakes, etc., gave similar patterns, which shows them to be composed of a mixture of substances having fairly large crystals in one case and substances having very small crystals in the other case.

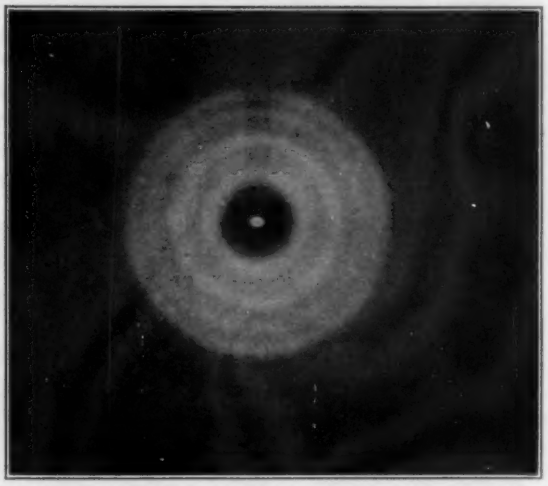

FIG. 4.—Unfired experimental porcelain composition.

Samples obtained from two unfired experimental porcelain shapes gave patterns (Fig. 4) consisting of concentric rings only, which indicates that they are composed of substances having small crystals. A similar pattern was obtained with calcined Georgia kaolin (Fig. 5). In Figs. 4 and 5 the diameters of the rings are different, which shows that the substances composing the unfired porcelain and the calcined clay have different crystallographic systems.

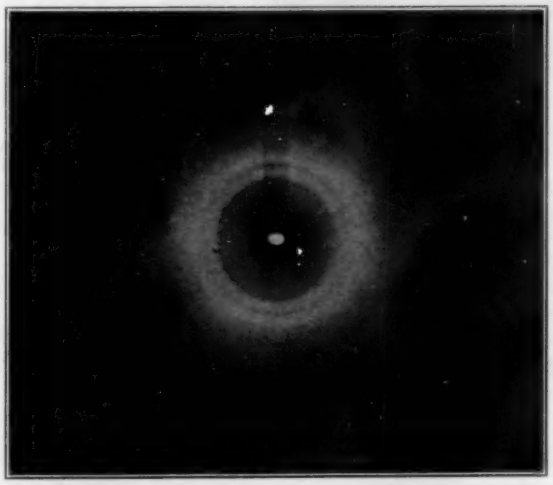

FIG. 5.—Calcined (cone 15) Georgia kaolin.

IV. Porcelain in Different Stages of Manufacture

Several of the porcelain shapes which had been extruded in the plastic state and turned in a lathe, were cut into $^1/_{16}$-inch sections perpendicular to the axis of the sample. This made X-ray examination of every part of the sample possible. No large variation in pattern was observed in any of these various sections, which would indicate that the particle size, distribution, and crystal composition are uniform.

Figure 3 indicates the typical pattern obtained for all such sections.

Patterns of finished ware appeared practically the same as those obtained for the unfired sample. This indicates that in the porcelain examined the crystals which are responsible for the diffraction pattern were not appreciably altered by the firing process. The diffraction patterns obtained on all unfired samples indicated a smooth cristobalite ring, which was absent in patterns obtained after the ware was fired.

A sample of body obtained from a filter-press cake was prepared by grinding the sample to pass a 200-mesh screen and holding it in place with thin walls of cellophane. The resulting diffraction pattern (Fig. 6) consists of the same diameter rings as were obtained for the extruded, turned, and fired samples, which indicates the same crystallographic composition. The increased coarseness of the pattern indicates the average particle size to be somewhat greater.

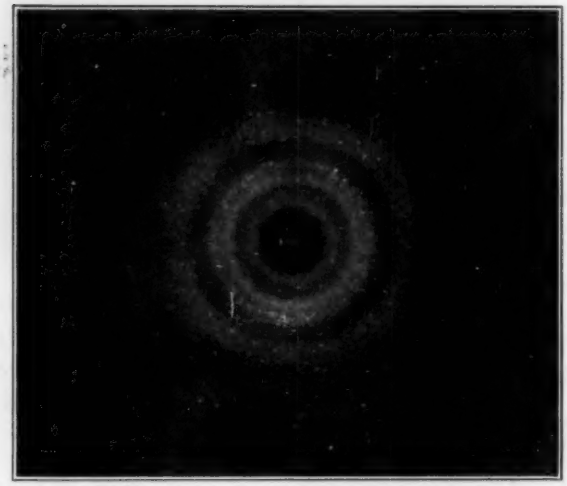

FIG. 6.—Porcelain mixture from ground filter-press cake.

V. Determination of Strains

It is conceivable that inherent stresses in the porcelain may cause the following effects, either singly or combined:

(1) Warping of the crystals.
(2) Fragmenting of the crystals.
(3) Slipping between crystals and the glassy matrix.
(4) Slipping in the matrix alone.

The first two types are distortions of the crystalline phase and can be disclosed by means of diffracted X-rays. The latter two are distortions of the amorphous matrix or the continuous phase and cannot be determined readily by this method.

Normal crystals are made up of regularly spaced atoms or molecules lying in planes. Monochromatic X-rays diffracted from these planes under proper conditions cause an image of the focal spot of the X-ray tube to appear on the film. If the crystal is stressed below its elastic limit the planes are warped and cause the diffracted image to be distorted. With strictly monochromatic radiation this effect would be difficult to observe;

in ordinary work, however, there is always a good percentage of continuous radiation present along with the monochromatic and this aids in the detection of distortion. Such is indicated in Figs. 7 and 8, which are patterns obtained for normal and strained mica.

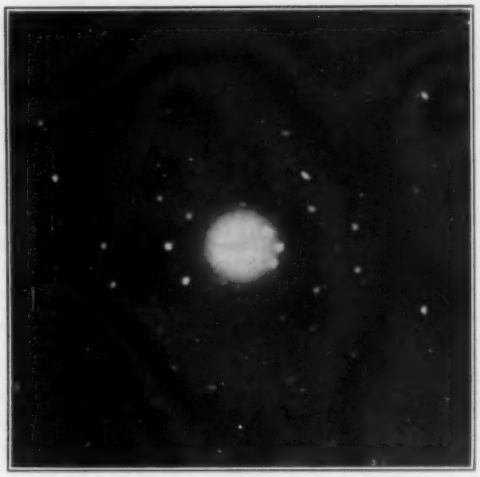

FIG. 7.—The diffracted images of the normal mica crystals are round and sharp indicating that they are in an undistorted condition. The images are much larger in this pattern than in those of the porcelain samples, because the crystals of mica are much larger than those of the mullite in the porcelain.

Crystals having a low elastic limit might not bend appreciably but shatter instead and cause slight displacements and rotations to take place along the slip planes. These resulting crystal planes remain nearly flat and parallel and the image diffracted by them is spread out and diffuse. Ordinarily strains in materials are detected by the appearance of individual images rather than that of the pattern as a whole.

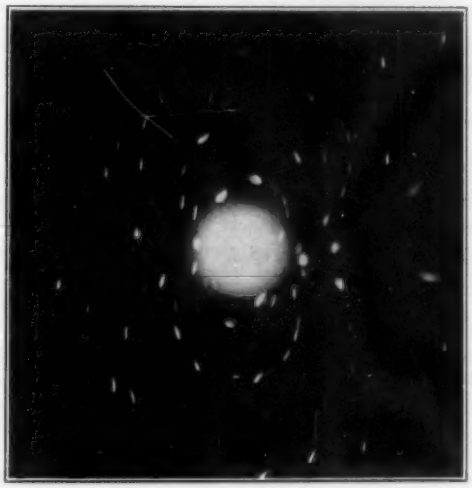

FIG. 8.—Mica under external stress. The diffracted images of the elastically bent mica crystals are elongated.

To determine what effect strains in the sample would have upon the diffraction pattern, an attempt was made to introduce them purposely by means of compression. No change in pattern was indicated when a porcelain disk was held under compression by a special clamp. After the photograph was taken, the sample cracked with very slight addition in clamp pressure. This indicates that if strains are in the crystals these crystals have very little elasticity and consequently either definitely retain their form or break.

A porcelain disk was heated

red hot and quenched in water. A photograph taken after this treatment showed no evidence of crystalline strain, which indicates that the porcelain probably recovered very rapidly from this treatment.

To accentuate strain conditions, the lower half of a disk of porcelain was raised to a high temperature by contact with a nichrome ribbon heated red hot by an electric current. At the same time the upper half was cooled by a stream of air. A diffraction photograph was taken of the region where the temperature gradient would be the greatest, but no evidence of strains was observed in the first series of tests.

Since this first series of temperature-gradient tests was completed the sensitivity of the diffraction apparatus has been increased and it was thought advisable to repeat them. A very slight variation of the patterns from the same region of a porcelain disk taken under normal conditions and under a high temperature gradient has been observed. The effect was so small that to notice it a minute study of individual diffraction images both in the strained and unstrained state was necessary. The effect is much smaller than was expected since the X-ray has proved extremely sensitive in detecting small strains in metals. These results indicate that the strains produced by artificial means in the larger class of crystals of the porcelain were very small if present at all.

Many of the studies described earlier in the article upon inherent and superimposed strains in porcelain are being repeated with the more sensitive apparatus.

VI. Conclusions

(1) No variation in size distribution or crystal composition was found in any section of extruded turned sample of porcelain.

(2) Fired samples gave the same pattern, except for the absence of the cristobalite line, and hence indicated the same size distribution as the extruded turned samples. The pattern from the raw clay particles in the unfired ware was obscured by that of the other constituents.

(3) A sample from filter-press cake indicated larger grains of more varied size distribution than did the other samples.

(4) Strains were not detected when the sample was placed under a compressive force of sufficient magnitude to nearly fracture the sample.

(5) No evidence of strains was observed in a sample which had been heated red hot and quenched in water.

(6) It is barely possible that very small strains were detected in the area of greatest temperature gradient when half the sample was maintained red hot and the other half cooled by a stream of air.

MANUFACTURE OF THIN PORCELAIN PARTS OF CLOSE DIMENSIONAL TOLERANCES[1]

By L. I. Shaw,[2] A. G. Johnson,[3] and W. J. Scott[3]

ABSTRACT

A method for manufacturing a porcelain washer 0.030 inch thick and 0.495 inch ± 0.003 inch inside diameter is described. Strength sufficient to allow the handling and trimming of the raw parts is secured by using waxes as the temporary binder of the dry ceramic materials, and forming under higher pressure. As the plasticity necessary for forming is obtained with wax, the stresses and resulting deformation incident to the use of clay plasticized with water are eliminated. Lower, more uniform shrinkage with resultant closer dimensional control is thus obtained.

I. Introduction

The thin ceramic insulator required in handset telephone transmitters, known as the "barrier," must be made to very close tolerances on thickness, diameter, and form of the inner edge so that the transmitter may have satisfactory electrical characteristics. It must also be very smooth and uniform in thickness to withstand the pressure of 2000 pounds per square inch with which it is clamped in the transmitter assembly. Chips and burrs, particularly on the inner rounded surface and the inner edge are objectionable. Figure 1 shows a section of the transmitter and the barrier is shown in cross-section in Fig. 2.

Before the present method of manufacture was developed, barriers were machined from rod talc at a cost which was very high because of flaws in the rod stock and nonuniform shrinkage during firing. The molding composition and the method of manufacture by which these barriers are now made at a low cost and with close dimensional tolerances will be described.

II. Body Composition

(1) Organic Binder It was necessary to obtain a binder which would give the raw molded part sufficient strength to withstand handling and trimming, and which would not give trouble in firing. It was found that 20% or less of such organic substances as pitches, resins, asphalts, paraffins, and waxes, could, when incorporated in the ceramic materials, be molded under high pressure to produce parts of the desired strength. Contrary to expectation, these temporary binders could be burned out in firing without deformation of the fired parts.

Compositions employing binders of the higher melting points and of

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greater hardness had to be molded in steam-heated molds. By using ordinary paraffin the barriers could, however, be molded cold with a consequent reduction in molding time. A small percentage of carnauba wax was added to the paraffin to increase the rigidity of the molded barriers.[4]

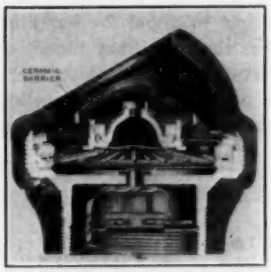

FIG. 1.—Cross-section of transmitter, hand-set type telephone.

(2) Mineral Composition It is necessary to limit the wear of the molding die to maintain close dimensional tolerances without excessive die expense. For this reason and because it is not necessary to vitrify the barrier, talc is used as the chief body constituent. Florida plastic clay equal by weight to one-third of the talc is added to secure greater density in both the molding material and the finished part.

This composition has a low and uniform total linear shrinkage of 4%, due chiefly to the use of wax as the plastic. As no water is present, the clay probably functions as a finely-divided nonplastic which remains structurally homogeneous in the molded part. The variations in molded structure caused by plastic clay and the resultant variable shrinkage and warpage are thus eliminated. Shrinkage and warpage caused by the removal of water in drying are absent.[5]

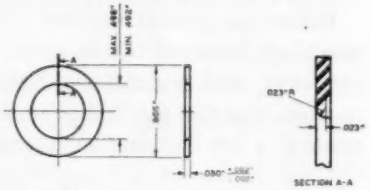

FIG. 2.—Molded porcelain barrier.

[4] Before the present composition and method of manufacture was developed, an attempt was made to manufacture barriers by the well-known method of dry-pressing a clay body plasticized with water. The chief difficulty encountered with this method was the fact that the molded part could hardly be extracted from the molding die without breaking and would not withstand the necessary handling and trimming operations.

Although the above combination of waxes is satisfactory in the manufacture of barriers, it is realized that in application to other parts of different sizes or shapes waxes or wax combinations will be required which differ in their properties. The strength of the molded part, the sharpness of outline, and the dimensional tolerances required in the final product are the chief considerations in determining the most desirable plastic material whether it be plasticized with water or a combination of waxes. Other considerations are the working pressure available with molding equipment, the cost of material, the effect of the firing cycle, and the economics relating to production requirements.

[5] It is also true that feldspar bodies bonded with waxes have been successfully fired to vitrification with lower total shrinkage than the same body when plasticized with water. Feldspar bodies are, however, inherently more abrasive than talc bodies and in consequence the die wear is greater. Feldspar bodies are, therefore, not used in the manufacture of barriers.

(3) Zinc Stearate Because of the relative high pressure used and the thinness of the molded barrier, the lubrication of the die surfaces is very critical. Too little oil results in sticking and too much oil is partially absorbed by the granular molding material, thereby weakening the molded barrier. Application of the lubricant to the die surface was finally eliminated entirely by tumbling the granulated molding material with 0.3% by weight of powdered zinc stearate. The grains of molding material are coated with the powder in this tumbling operation and the resulting mixture molds perfectly without additional lubricant.

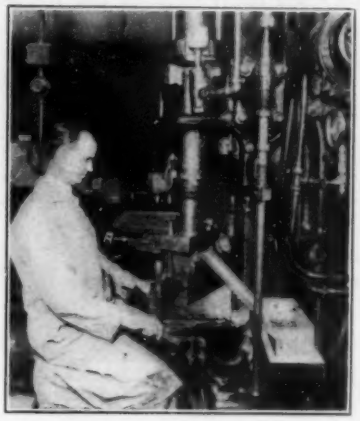

FIG. 3.—Press operation in manufacture of molded barriers.

(4) Body Preparation The waxes are first dissolved completely in carbon tetrachloride at a temperature of approximately 168°F. This solution of waxes together with the talc and the clay are then thoroughly mixed in a ball mill for two hours. The resultant mixture, which has the consistency of a thick slip, is then completely dried.

This mixture is stirred thoroughly at short intervals throughout the drying period to avoid any segregation of the waxes. After drying, the body is disintegrated and then screened through 60- and 100-mesh screens. Material coarser than 60-mesh is again disintegrated and screened while material finer than 100-mesh is mixed with carbon tetrachloride, dried, disintegrated, and re-screened. The 60- to 100-mesh material is used for molding barriers.

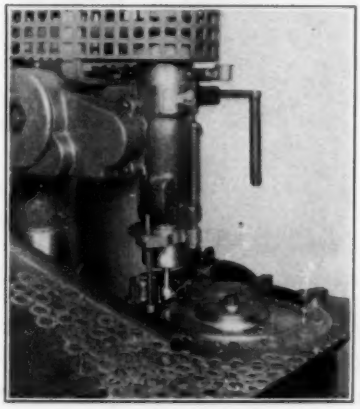

FIG. 4.—Indexing head and end cutter of finning machine.

III. Pressing

The barriers are molded in a commercial 20-ton oilgear press (Fig. 3), four at a time. The molding operation is held to an accuracy in thickness of 0.034 ± 0.0015 inch.

The die cavities are filled by a sliding hopper "A" and the barriers are molded with a single stroke of the ram. Knock-out sleeves then raise the

molded parts until their lower surfaces are flush with the top surface of the die. The parts are then transferred to the delivery chute by the next forward movement of the hopper. The operator is required to use both hands to actuate the press, thus eliminating the possibility of lowering the ram while his hand is between the dies.

The dies have a life of approximately 1,000,000 parts before undercuts or wear make repair necessary.

FIG. 5.—Firing of molded barriers.

IV. Finning and Trimming

It is necessary to remove the molding fins and to trim the barriers down to a thickness of 0.0320 ± 0.0005 inch. This operation is performed on a finning machine shown in Fig. 4. It is an adaptation of an automatic drill press. A vacuum chuck holds the parts in position under the cutter which removes the fins and trims the barriers to the required thickness. Both the fins and the dust from finning are collected by suction. The parts are automatically discharged from the finning machine into a container.

V. Firing

After finning and trimming, the parts racked in small soapstone trays are then fired to cone 12 in a small direct gas-fired tunnel kiln. Figure 5 shows a view of the kiln and parts ready for firing.

FIG. 6.—Gaging diameter of molded barriers.

VI. Gaging and Inspection

The barriers are gaged for thickness, roundness, and inside diameter immediately after firing. "Go" and "no-go" plug gages were employed initially for checking the inside diameter.[6] After the dimensional inspection, the parts are given an inspection for cracks, warpage, and burrs, and are then individually inspected under a 10 to 1 glass for smoothness and regularity of the inner edge, after which they are packed and sent to the assembly department.

[6] This operation is now much more satisfactorily performed on the special indicator gage shown in Fig. 6, which is much faster than the plug gages. It will be noted that the lower jaw of the gage is smaller than the upper jaw. The parts are checked for roundness by repeated measurements in different positions on the gage. The limits on inside diameter are 0.495 ± 0.003 inch and on thickness 0.030 inch ± 0.002 inch.

PROGRESS OF FLUIDITY IN PORCELAIN BODIES[1]

By R. A. Snyder

ABSTRACT

Firing characteristics of a group of thirteen clay-flint-feldspar porcelain bodies were studied. Firing shrinkage, porosity, and rate of deformation were determined on specimens of all bodies fired at a series of temperatures, thus observing the rate of vitrification and subsequent fluidity of each of the bodies in question. Cross-breaking strength tests were made in order to ascertain the relation of composition and firing temperature to mechanical strength.

I. Introduction

Factors affecting the vitrification behavior of clay-flint-feldspar porcelains have been the subject of considerable experimentation. Rieke[2] has investigated the effect of grain size of the nonplastics on vitrification progress of such bodies. He has shown that finer grained feldspar lowers the porosity and sintering point of a porcelain. Shrinkage at all firing temperatures increased with decreasing size of grain of the feldspar. Bleininger and Kinnison[3] have determined the effect of composition upon viscosity of porcelain bodies at firing temperatures by measuring the tendency of bodies to elongate when fired under tensile load. They found, in general, that the effect of higher feldspar or clay was to increase viscosity in a marked degree. In the higher feldspar bodies, flint did not seem to be an important factor in influencing the viscosity.

Such information has furnished a valuable indication of the character and amount of the glass phase developed and has been of service in the selection of bodies least subject to deformation in the firing process. Few attempts, however, have been made to correlate the physical properties of porcelain and the progress of fluidity throughout the entire firing and overfiring stages. The object of this work was to gain definite information concerning the rate of vitrification of a number of clay-flint-feldspar porcelains, and their tendency to deform during firing has been measured. Detailed porosity and shrinkage data were obtained in order to study the relations between degree of vitrification and rate of fluidity development.

II Procedure

The compositions of the bodies studied are represented in Fig. 1. Body No. 1 may be considered as being a typical electrical porcelain while the others represent 5 or 10% replacements of the end members. The clay

[1] Presented at the Annual Meeting, American Ceramic Society, Cleveland, Ohio, February, 1931 (White Wares Division). Revised copy received March 12, 1931.

[2] R. Rieke, "Influence of Grain Size of the Non-Plastics upon Firing Behavior of White Ware Bodies," *Sprechsaal*, Nos. 20–29 (1917).

[3] A. V. Bleininger and C. S. Kinnison, "The Viscosity of Porcelain Bodies," *Trans. Amer. Ceram. Soc.*, 17, 130–36 (1915).

content was made up of Georgia kaolin and two ball clays usually used in the body. The ball clay portion was kept constant at 30% of the batch in order to maintain workability as nearly uniform as possible.

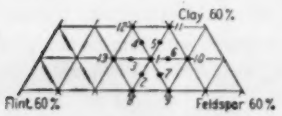

FIG. 1.

(1) Preparation All bodies were made up in 2000-gram batches and ground for two hours in gallon laboratory ball mills, using a constant weight of pebbles (2000 grams) and a constant volume of distilled water (2300 cc.). The resultant slip was passed through a 100-mesh sieve, then filter-pressed, using air pressure at 85 pounds per square inch. Round test specimens, $^1/_2$ inch in diameter by $3^1/_2$ inches long were formed by extruding the wedged clay through the die of an extrusion machine which consisted of a cylinder and an electrically-driven plunger. Specimens formed in this manner are free from voids and pugmill defects and give uniform results in testing, showing a deviation of only 5% from average. Square bars were hand-molded for the deformation tests. After drying, these were accurately finished to $^{11}/_{16}$ by $^{11}/_{16}$ by $5^1/_2$ inches by sanding.

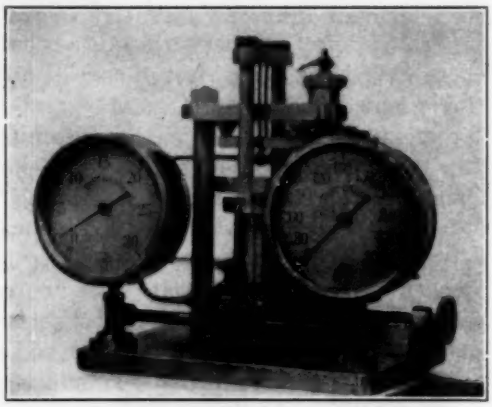

FIG. 2.

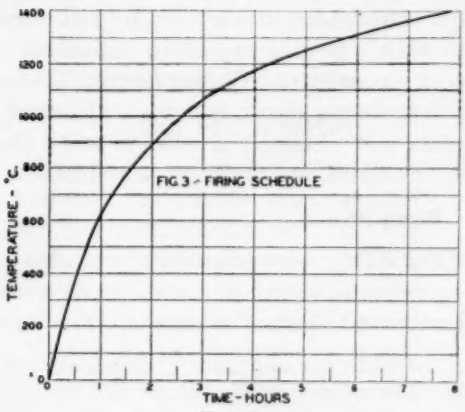

FIG. 3.

(2) Firing Firing of round bars for shrinkage, transverse strength, and porosity determinations, as well as firing of deformation specimens was done in a muffle kiln in accordance with a definite firing schedule (Fig. 3). This furnace is equipped with a Maxon-Premix blower which delivers the gas and air mixture to four burners located beneath the muffle. Temperature uniformity within the muffle is within one-half cone. Temperature was measured by

means of a Pt Pt-Rh thermocouple and a recording potentiometer. Pyrometric cones were used where and as indicated.

III. Results

(1) Linear Firing Shrinkage

Firing shrinkage was determined by measuring the diameters of the test specimens with a micrometer before and after firing, and computing the shrinkage on the dry basis. The test bars were uniform and perfectly circular in cross-section and therefore justified this method of obtaining shrinkage. The shrinkages of the thirteen bodies at the various firing temperatures are given in Table I.

TABLE I

LINEAR FIRING SHRINKAGE

Body	Cone 7	Cone 9	Cone 11	Cone 13	Cone 15
1	13.5%	13.7%	13.5%	13.9%	6.2%
2	12.3	12.9	13.4	12.8	4.6
3	12.1	12.7	13.5	13.5	8.5
4	13.5	13.9	14.2	14.4	10.1
5	14.5	14.5	14.5	10.9	8.7
6	13.7	14.1	14.3	10.1	7.8
7	13.4	13.6	13.8	12.6	6.0
8	12.2	11.8	13.1	12.0	2.4
9	13.0	12.6	12.8	11.2	2.4
10	14.2	14.2	14.4	13.1	8.6
11	14.6	15.2	15.2−	15.2	12.9
12	12.7	13.5	14.2	14.9	14.6
13	11.2	12.3	12.9	13.6	12.9

TABLE II

TRANSVERSE STRENGTH (lb. per sq. in.)

Body	Cone 7	Cone 9	Cone 11	Cone 13	Cone 15
1	12,040	11,740	11,120	9,660	8,160
2	9,180	11,330	11,530	10,480	7,200
3	9,310	12,140	11,890	12,780	8,880
4	8,900	12,260	11,130	11,590	7,560
5	12,900	11,540	11,090	8,730	8,220
6	12,430	11,030	11,340	8,480	7,570
7	10,950	10,630	9,320	9,330	7,330
8	8,390	11,650	11,190	10,180	6,520
9	11,470	10,400	10,130	8,470	5,740
10	12,000	9,620	11,170	9,790	6,950
11	11,440	11,010	11,270	11,010	9,420
12	9,670	9,090	10,230	11,240	11,960
13	8,330	8,740	8,840	11,150	10,940

(2) Transverse Strength

Transverse strength tests were made with the hydraulic cross-bending machine shown in Fig. 2. Compressed air operates the piston in the rear cylinder, forcing oil into the front cylinder and pushing its piston upward, thus applying the load to the specimen. A small steel cable transmits the load to the specimen, which assures uniform stress distribution at the point of contact.

The machine is equipped with two pressure gages, one calibrated to 30 pounds and used when testing unfired specimens, while the other has a capacity of 300 pounds and is used for work with fired ceramic materials. The area of the front piston is 1 square inch so that the total load applied

TABLE III

POROSITY VALUES

Body	Cone 7	Cone 9	Cone 11	Cone 13	Cone 15
1	0.28%	0.21%	0.08%	0.0 %	0.98%
2	0.83	0.19	0.15	0.09	7.3
3	6.48	0.25	0.10	0.00	
4	0.99	0.29	0.09	0.18	3.3
5	0.20	0.19	0.09	0.76	3.9
6	0.32	0.15	0.00	0.70	3.0
7	0.22	0.20	0.12	0.32	4.7
8	3.22	0.39	0.00	0.36	8.5
9	0.24	0.38	0.19	0.48	5.5
10	0.07	0.17	0.17	0.70	3.4
11	0.36	0.29	0.00	0.00	0.0
12	11.13	1.99	1.97	0.06	0.21
13	11.37	5.74	1.32	0.08	0.17

to the test piece may be read direct. A needle valve controls the passage of oil into the front piston and hence the rate of application of load. A span of $2^1/_2$ inches was used in this work. Modulus of rupture was calculated by means of the following formula:[4]

$$M = \frac{8PL}{\pi D^3}$$

Table II gives the transverse strength of the bodies under consideration.

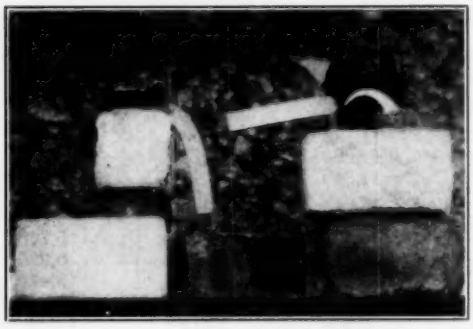

FIG. 4.

(3) Porosity An air expansion porosimeter of the type described by MacGee[5] was used in obtaining porosity data. The porosities of all bodies at their five firing temperatures are given in Table III.

(4) Deformation The deformation behavior of the various bodies was determined by observing the rate and degree of bending which took place when cantilever beams of the bodies were fired. Figure 4 shows the method of supporting the square bars, $3^1/_2$ inches being

[4] L. Navias, "Impact and Static Transverse Strength of Wet-Process Electrical Porcelain," *Jour. Amer. Ceram. Soc.*, **10**, 90–97 (1927).

[5] Standards Report, *ibid.*, **11**, 499–501 (1928).

TABLE IV

DEFORMATION (cm.)

Body	Cone 7	Cone 9	Cone 11	Cone 13	Cone 15
1	0.00	0.03	0.06	0.12	1.15
2	0.00	0.00	0.07	0.12	2.11
3	0.00	0.00	0.00	0.02	1.05
4	0.00	0.00	0.00	0.06	0.42
5	0.00	0.00	0.03	0.15	0.64
6	0.00	0.00	0.04	0.16	0.77
7	0.00	0.00	0.10	0.37	0.84
8	0.25	0.33	0.41	0.70	3.82
9	0.00	0.06	0.20	0.96	4.43
10	0.00	0.04	0.08	0.16	1.24
11	0.00	0.00	0.00	0.06	0.56
12	0.00	0.00	0.00	0.03	0.21
13	0.00	0.00	0.00	0.00	0.94

the unsupported length in each case.[6] The firing schedule shown in Fig. 3 was followed and readings of the deformation taken at intervals of 15

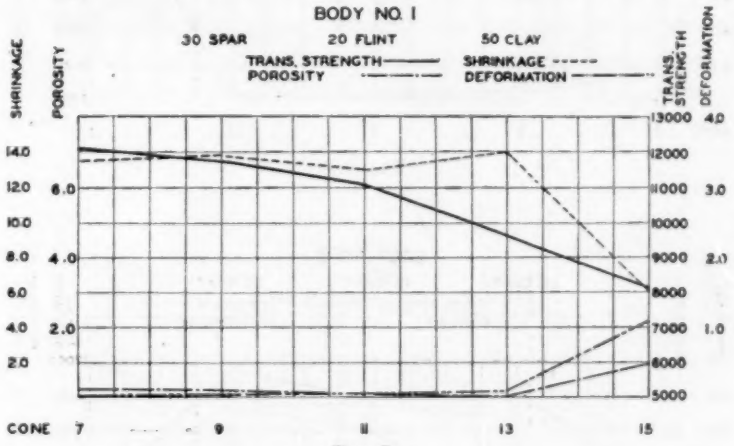

FIG. 5.

minutes by means of a cathetometer focused on the lower tip of the bar. Table IV gives the data obtained in this work.

IV. Summary and Conclusions

The data for each of the bodies studied are represented graphically in Figs. 5–17. From these it is seen that at the lowest firing temperature, cone 7, greatest strength was developed by the bodies highest in feldspar

[6] The bar shown on the left in Fig. 4 was a talc composition and the other a typical electrical porcelain. Both had been fired to a temperature which exceeded the normal firing temperature of the talc body by only 40 °C, but which was 100 °C above the maturing temperature of the electrical porcelain. The illustration shows clearly the marked tendency of such a magnesia body to deform on overfiring. The porcelain, however, retains high viscosity far beyond the usual firing temperature.

and containing the least amount of flint. This probably indicates considerable reaction between clay and melting feldspar which apparently contributes to the bonding power of the glass phase. Strength seems to be

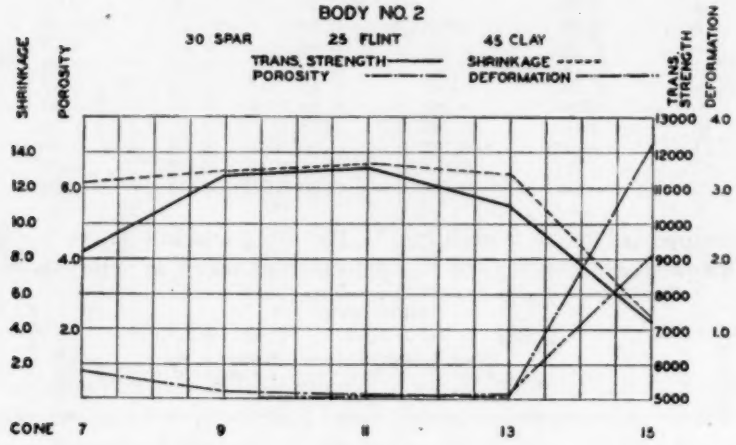

FIG. 6.

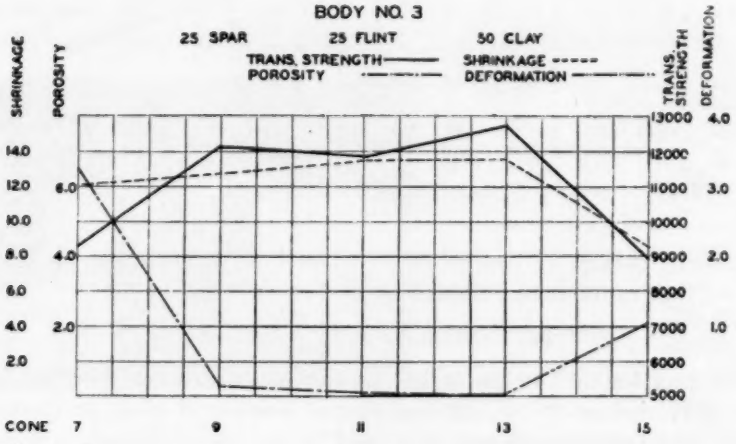

FIG. 7.

dependent upon the proportion of fluid developed, since this group (1–5–6–7–9–10–11) has low porosity and shrinkage in all cases has practically reached a maximum.

The ease with which feldspar takes clay into solution as compared with flint is well demonstrated by bodies 9 and 10, containing equal proportions of feldspar. Thus, No. 9 (20% flint) has a considerably higher porosity,

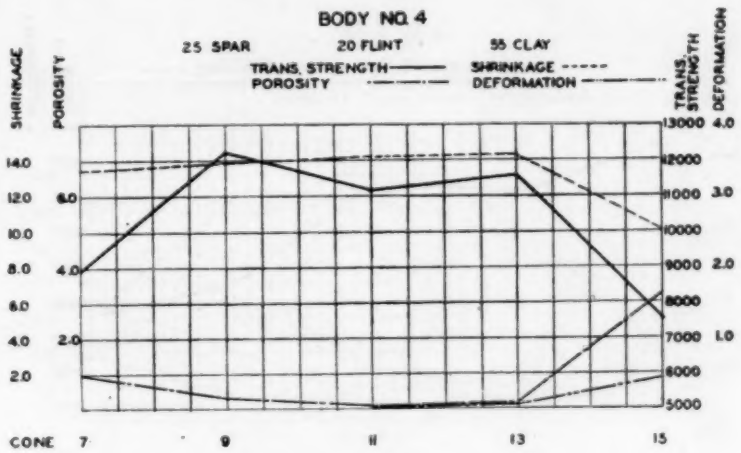

FIG. 8.

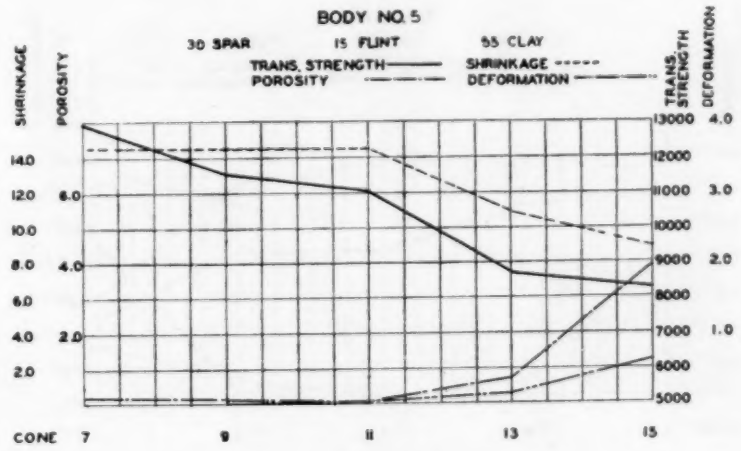

FIG. 9.

lower shrinkage, and mechanical strength than does No. 10 (10% flint). With increased firing temperature, the area of highest strength tends to move toward the high clay-low feldspar compositions. It is noticeable

that the higher flint compositions in general do not seem to develop mechanical strength to an extent exhibited by those richer in clay and feldspar. Also, on overfiring, the low clay compositions in which one would expect

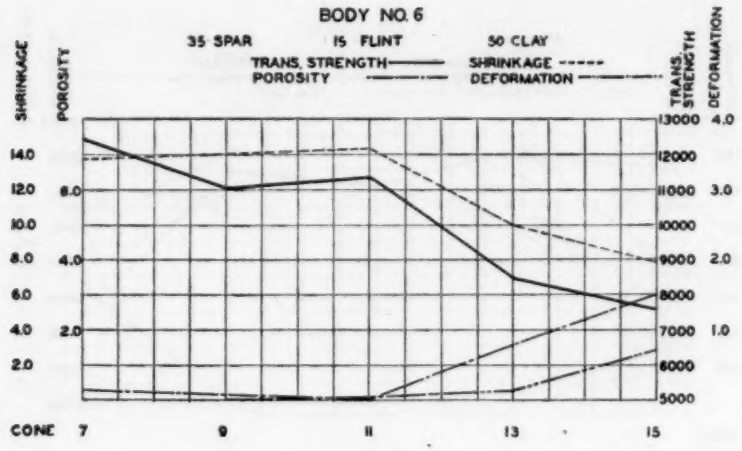

FIG. 10.

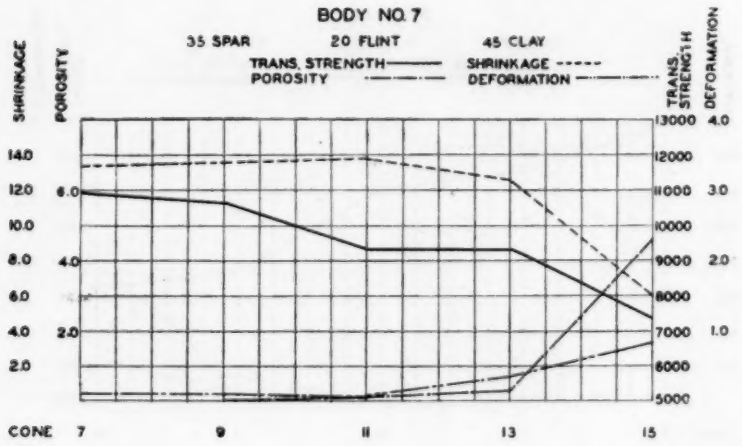

FIG. 11.

an appreciable degree of solution of quartz, the tendency to lose strength appears to be most noticeable. Thus, in the case of No. 8 and No. 11, both of which are practically vitreous at cone 11, the former undergoes a loss of

strength of 42% in passing from cone 11 to cone 15, while the latter shows a loss of only 17%. The tendency of the high flint composition, No. 8, to bloat and develop vesicular structure is also much greater than in No. 11.

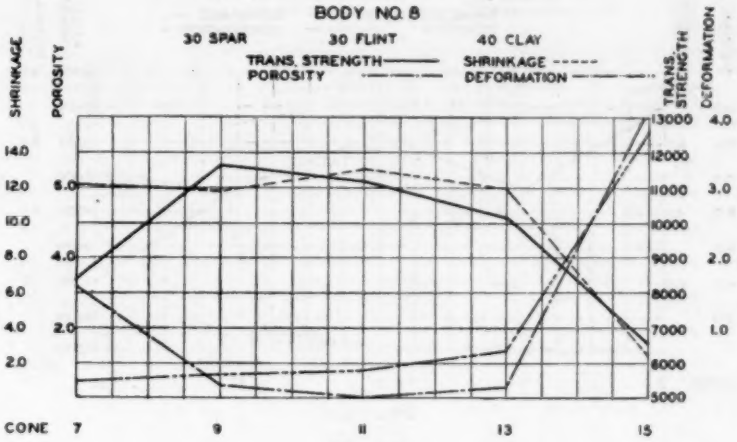

FIG. 12.

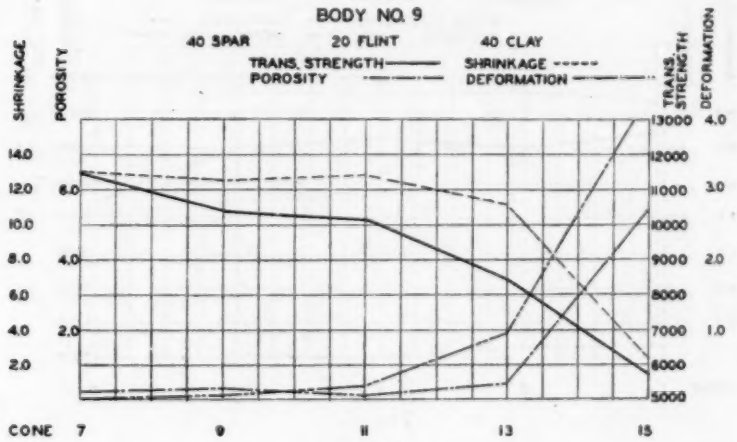

FIG. 13.

The rate of vitrification seems to be influenced most seriously by flint content. The widest vitrification range was observed in bodies containing less than 20% flint and at the same time such compositions tended to maintain high mechanical strength over a longer period.

Deformation begins at lowest temperatures in the bodies highest in feldspar and flint and at the highest firing temperature maximum deforma-

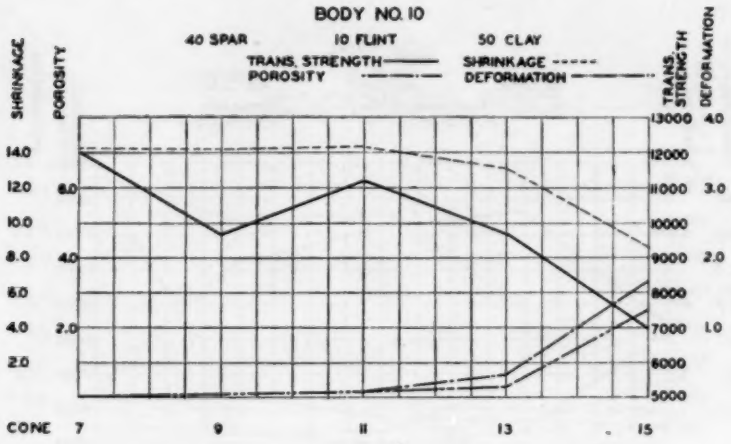

FIG. 14.

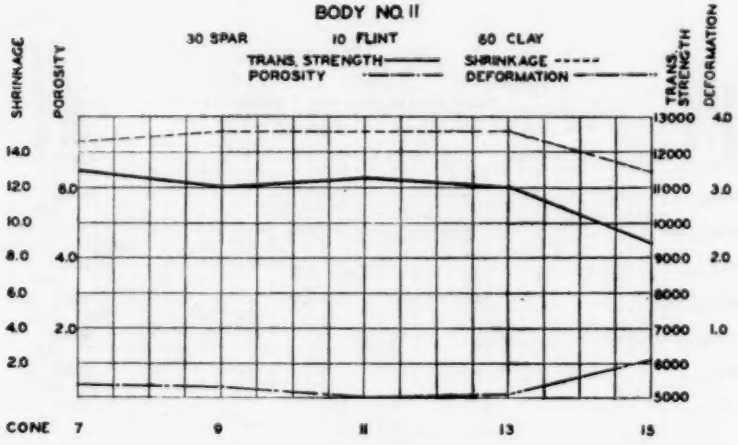

FIG. 15.

tion occurs in low clay bodies. The extremely viscous nature of higher clay compositions is well shown by bodies 9 and 10. These contain equal amounts of feldspar, but No. 10 (50% clay) with a total deformation of 1.24 cm. at cone 15 is much more viscous than No. 9 (40% clay) which has a total deformation of 4.43 cm.

Within the range of compositions studied there is no tendency toward development of unusually high strengths by any of the bodies at the higher

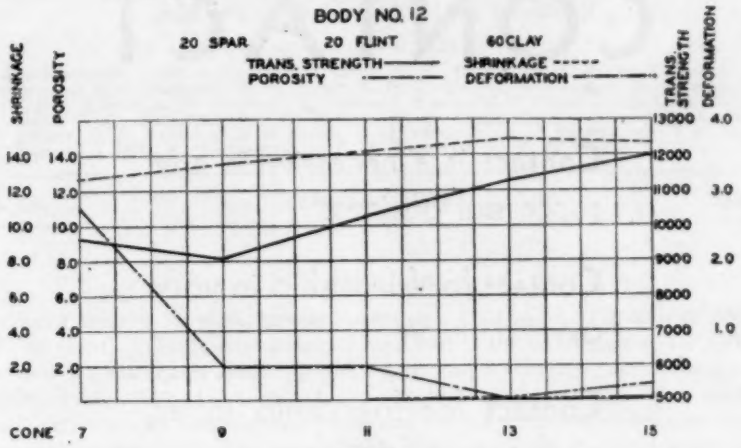

FIG. 16.

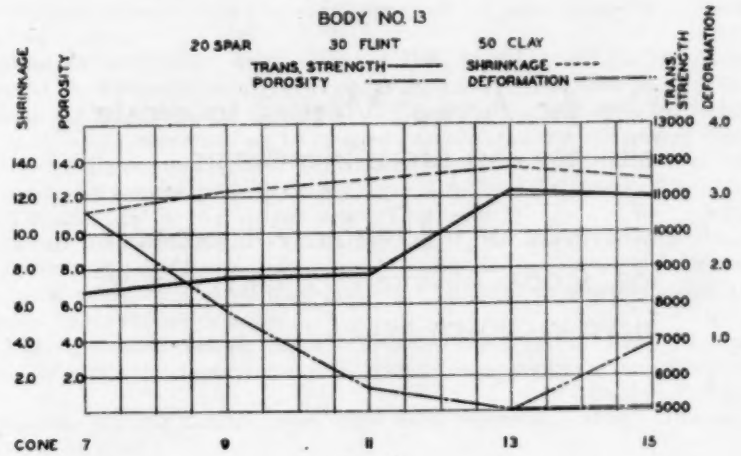

FIG. 17.

temperatures. From this it appears that no advantage is to be gained by firing electrical porcelain to higher temperatures than at present.

Acknowledgment The author wishes to express his thanks to H. M. Kraner for helpful advice and criticism during the progress of the investigation.

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CERAMIC ABSTRACTS[1]

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Vol. 10 **November, 1931** **No. 11**

Abrasives

Graded abrasive for metallographic polishing. J. L. Rodda. *Mining & Met.*, **12** [297], 20 (1931).—Commercial abrasives have been found unsatisfactory for polishing because of the wide range in particle size. A method of separating such abrasives into portions having a limited uniform range of sizes has been worked out. This work was carried out mainly with alumina and emery and the size of the particles was checked by microscopic examination. The essential steps in the process are (1) thorough dispersion of the abrasive in water by using a small amount of sodium silicate as a peptizing agent and dispersing in either a colloid mill or pebble mill and (2) allowing the abrasive suspension to settle for a definite time and siphoning off to a predetermined depth, using the siphoned material. E.J.V.

Adopt abrasive label. Anon. *Abrasive Ind.*, **12** [9], 41–42 (1931).—Henry R. Power of the Carborundum Co., chairman of the standing committee on simplification program 118, has announced that the U. S. Department of Commerce has authorized a label for use on loose abrasives, by those who are conforming to the grading standards of simplification program R. 118. The wording which has official sanction is as follows: "This abrasive has been made to comply in size with Simplified Practice Recommendation 118, issued by the U. S. Department of Commerce." E.P.R.

Aircraft accuracy. Anon. *Abrasive Ind.*, **12** [9], 14–17 (1931).—Exceptional accuracy with intensive production of aircraft motors has been brought about through the liberal employment of precision grinding. The grinding operations used at the Marmon Motor Co. are described. E.P.R.

Grinding airplane engines. Anon. *Abrasive Ind.*, **12** [9], 17 (1931).—The manufacture of airplane engines involves production precision grinding of the highest order. E.P.R.

Accurate jigs and fixtures assure close work. Fred B. Jacobs. *Abrasive Ind.*, **12** [9], 19–20 (1931). E.P.R.

Causes of cracks in hardened steel. C. E. Sweetser. *Abrasive Ind.*, **12** [9], 21–24 (1931).—Occurrence of cracks in the ground surfaces of hardened steels under seemingly normal conditions of manufacture is caused either by heat treatment or by grinding. The real problem is to distinguish between these two causes. This article reports and discusses the results of a test. A comparatively severe degree of grinding abuse is required to crack steel which has been correctly heat treated. On the other hand, steels which have been subjected to extremely severe heat treatment may be

[1] The abbreviation (*C.A.*) at the end of an abstract indicates that it was obtained from *Chemical Abstracts* by coöperative agreement.
The bold-face number following the journal name is the volume, the issue number is in brackets followed by the page numbers, then the year in parentheses.

cracked with little, if any, abuse by grinding. Cracks may be identified with their causes by observing their size, form, number, and location after etching. Those which are few in number and comparatively wide and deep point to abusive heat treatment as the predominating cause. Cracks which occur in the form of a fine surface network indicate incorrect heat treatment and decidedly abusive grinding. E.P.R.

Centerless blade life is increased. ANON. *Abrasive Ind.*, **12** [9], 24 (1931).—The tooling-up program of one user of centerless grinders now calls for cemented tungsten-carbide blades as standard equipment on all grinders from 10 in. up. E.P.R.

Sharpening stones as precision tools. ANON. *Abrasive Ind.*, **12** [9], 33 (1931).—The oldest abrasive used is the sharpening stone which is now made in various abrasives and in any grit and is applicable to precision work. E.P.R.

Grinding between centers. ANON. *Abrasive Ind.*, **12** [9], 26–27 (1931).—Cylindrical grinding between centers, the forerunner of all modern precision methods, had its origin when the first mechanic thought of mounting an emery wheel on the carriage of a lathe. The universal grinder usually is fitted for surface and internal grinding as well as external cylindrical grinding. In addition, special attachments permit almost any grinding operation with the exception of centerless methods. The decrease in cutting efficiency due to a decrease in peripheral speed resulting from wheel wear is disregarded in the design of most precision cylindrical machines. When the work is light and can be set up easily on the grinding machine the recommended practice is a roughing cut with a coarse wheel followed by a finishing cut with a fine wheel. E.P.R.

Wheels for smooth finish. CARBORUNDUM CO. *Abrasive Ind.*, **12** [9], 28 (1931).—Solid grinding wheels capable of producing extremely high finishes formerly attainable only by lapping with compound or other loose-grain agencies are being made. To develop such a grinding wheel it was first necessary to produce uniform grain or grits of finest sizes. Both aluminium oxides and silicon carbide are used in making these wheels, depending upon the character of the material to be ground or finished. These powders are said to be as perfectly uniform in individual grit size as science and skill can make them. Grinding machine manufacturers have perfected their machines practically to eliminate vibration. The finishes required must be the result of a progression, a building up of comparably finer finishes with a series of progressively finer wheels, and a consequent diminishing stock removal to prepare the surface for the final finish. The new type of wheels is not expected to do production grinding in the sense of the removal of large amounts of metal. E.P.R.

Grinding radio condenser plates. ANON. *Abrasive Ind.*, **12** [9], 17 (1931).—The grinding operation is described. E.P.R.

Machinery replaces manual skill in grinding. ANON. *Abrasive Ind.*, **12** [9], 42 (1931). E.P.R.

Job polishing shop. ANON. *Abrasive Ind.*, **12** [9], 40–41 (1931).—The business of the Althoff Plating & Polishing Co. is to make old metals look like new, which includes an infinite variety of hand polishing, buffing, staining, and plating. Some of the work and methods used in rejuvenating old metal pieces is described. E.P.R.

Double-wheel grinding method for cast-iron and hard-alloy cylinder liners. ANON. *Abrasive Ind.*, **12** [9], 36–37 (1931).—The introduction of centrifugally cast and hard-alloy liners for the bores of automotive engine cylinders brought new problems in the finishing of the outer surfaces. It is essential for the liner to make a metal-to-metal contact with the bore of the cylinder. Grinding has proved the most satisfactory method, but difficulty has been experienced in the holding of the work and the prevention of distortion during grinding. The expanding arbor fitted to the special machine has proved successful in grinding this work because the adjustment is sensitive and eliminates the possibility of distortion. E.P.R.

Wheel dresser for shearing cut. ANON. *Abrasive Ind.*, **12** [9], 37 (1931).—This is a heavy-duty tool especially designed for dressing the large, coarse wheels bonded with synthetic resin and operated at high speeds. It is pointed out that the dresser will also work equally well on vitrified and silicate bonded wheels. E.P.R.

Adhesion of glue to fused-alumina abrasives. II. HENRY R. POWER. *Metal Cleaning & Finishing*, **3** [8], 675–76 (1931).—Tests have shown that the closeness of abrasive sizing does not affect adhesion of abrasive and glue. Maximum adhesion is obtainable by use of high-test glues. For Part I see *Ceram. Abs.*, **10** [10], 671 (1931). E.J.V.

Cutlery firm 200 years old. ANON. *Abrasive Ind.*, **12** [9], 27 (1931).—J. A. Henckels Zwillingswerk, Sölingen, Germany, celebrates its 200th anniversary this year. Modern grinding equipment is replacing manual operations throughout the plant. E.P.R.

BULLETINS

Prevention of skin irritations. ANON. *Abrasive Ind.*, **12** [9], 24 (1931).—Safe Practices Pamphlet No. 44, distributed to members by the National Safety Council, Inc., Chicago, contains suggestions regarding the safe use of cutting oils and emulsions. Typical skin troubles are described and methods of handling coolants and cutting oils for their prevention are outlined. E.P.R.

Diamonds. ANON. *Abrasive Ind.*, **12** [9], 39 (1931).—F. F. Gilmore & Co. has issued an illustrated circular describing wheel-truing diamonds. Various types of diamond points and special automotive service grinders are shown. Data pertaining to the resetting of diamonds and the depth of cut in wheel truing also is included. E.P.R.

Roll grinding data. ANON. *Abrasive Ind.*, **12** [9], 32 (1931).—The Farrel-Birmingham Co. has issued a booklet entitled "Assuring Production with Precision in Roll Grinding." Pertinent factors pertaining to roll grinding are given and a description of the company's heavy-duty roll grinder for roll and cylindrical grinding of all kinds and of the Farrel two-wheel swing-rest roll grinder for paper mill rolls is included. E.P.R.

Grinding data. ANON. *Abrasive Ind.*, **12** [9], 32 (1931).—An illustrated 48-page booklet entitled "Cutting and Grinding Facts" has been issued in its 2nd edition by the Sun Oil Co. The booklet shows by illustrations and accompanying data what is being done in various cutting and grinding operations with the company's products. Illustrations include lathe work, milling operations, gear cutting and hobbing, drilling, broaching, and grinding. The data included are taken from recent practice in production grinding operations. E.P.R.

PATENTS

Grinding machine. WALDO J. GUILD, RALPH A. QUIMBY, AND FREDERICK D. GIBBS. U. S. 1,819,091, Aug. 18, 1931. In a grinding machine, the combination with a grinding wheel having means for reciprocating it in an inclined plane and automatic means to dress and true the grinding wheel during cessation of its inclined movement, of a counting mechanism actuated synchronously with the reciprocating means, the counting mechanism being adapted to set the automatic dressing means in operation after the grinding of a predetermined number of work pieces.

Grinding machine. ROGER N. HEALD. U. S. 1,819,094, Aug. 18, 1931. In a grinding machine, the combination with cam means for advancing and retracting a work head in relation to a grinding wheel to produce a cutting feed therebetween and replacement to a position of no feed to allow the entry of a grinding wheel into a fresh work piece, of means for causing the wheel to withdraw from a work piece just prior to

the movement of the parts to the position of maximum feed, and means to cause the cam means to continue feeding after the withdrawal long enough to cause the retraction of the parts in relation to each other.

Polishing wheel. RALPH Z. HOPKINS AND EARL F. SEGER. U. S. 1,819,171, Aug. 18, 1931. A polishing or sanding device comprising a rotary drum having end-support members, a number of rubbing elements having offset portions and provided with slots, retaining members having tongues engageable with the slots and provided with eyelets, and a number of rods adapted to be inserted through the eyelets of the respective members and to be demountably secured between the end-support members.

External center grinder. CLIFFORD T. RAULE. U. S. 1,820,029, Aug. 25, 1931. In a multiple external grinding machine, a downwardly directed disk grinding wheel, an upwardly directed turntable parallel and eccentric thereto, work holders spaced at uniform intervals around the turntable, and parallel links supporting the individual holders from the table pivoted at one end to the table and at the other to the work holder, in combination with gearing adapted to rotate the holder having coöperating wheels coaxial with the pivots of one of the links.

Valve-seat grinder. JAMES E. WHITMILL. U. S. 1,820,368, Aug. 25, 1931. A valve-seat grinder comprising a grinding head of slightly less diameter than the valve chamber to permit its freely entering the latter, a star-shaped member having a shank portion by which it is integrally connected with the head but axially spaced from the same, the arms of the star-shaped member being of a radial extent to bring them in contact with the wall of the valve chamber, a grinding disk carried on the underface of the head, and a centering pilot protruding from the underface of the head for sliding engagement with the valve-stem guide.

Buffer wheel. ALEXANDER LEVETT. U. S. 1,820,465, Aug. 25, 1931. A buffer wheel, comprising a plurality of cloth disks arranged in side by side relation, applied cloth squares on each side of the wheel arranged to have the threads thereof extend on a bias to the threads of the adjacent disk, and a second cloth square applied over each of the first-mentioned squares and arranged to have the threads thereof extend parallel to the threads of the adjacent disk, the squares being secured to the wheel by stitching extending along each of the four edges thereof.

Abrasive wheel. HAROLD A. RICHMOND AND DAVID D. MACLAUGHLIN. U. S. 1,820,581, Aug. 25, 1931. An integral annular abrasive wheel having slots extending through the wall and a waterproof coating covering the inner ends of the slots.

Grinding machine. WARREN F. FRASER. U. S. 1,820,735, Aug. 25, 1931. A grinding machine comprising a rotatably mounted grinding wheel, a work-receiving turret having spaced undercut arms arranged to hold a multiplicity of duplicate work pieces in the turret, the work pieces being insertable axially between the adjacent arms, means to intermittently turn the turret and thereby successively present work pieces in the grinding zone, means for lifting a work piece from contact with the turret arms and centering and rotating it during the grinding operation, mechanism for releasing the work from the centering and rotating means for reception again by the turret, supporting means located near a work piece in the turret to receive the work, and a device actuated in timed relation with the turret movement to eject each finished work piece axially from the turret onto the support when the work has reached a predetermined position.

Abrasive testing machine. HARLEY H. LA VERCOMBE. U. S. 1,821,169, Sept. 1, 1931. In a machine for testing abrasive wheels, means for rotatably supporting an abrasive wheel, means for supporting a test piece in contact with the periphery of the wheel, and a variable speed driving mechanism through which the wheel-supporting means is rotated, means for adjusting the mechanism according to the distance of the

test piece from the center of the wheel, whereby the supporting means is rotated at speeds varying inversely as the diameter of the wheel.

Sharpening rotary circular knives of slicing and other machines. CORNELIS FRANCISCUS MARIA VAN BERKEL. U. S. 1,821,280, Sept. 1, 1931. A sharpener for rotary slicing-machine knives comprising a pair of grinders, one for major operation and the other for removing the burr, means for moving the grinders into and out of operative positions relative to a rotary slicing-machine knife to be sharpened, and mechanism for compelling a predetermined cycle of movements of the grinders while reversal thereof is prevented, such cycle of movements including movement of the major grinder into engagement with the knife followed by the movement of the burr grinder into engagement with the knife and after an interval while both grinders are in engagement with the knife, movement of the major grinder away from the knife leaving the burr grinder in engagement therewith for an interval after which upon continued operation the same cycle must be repeated.

Abrasive-stone holder. FRANK J. JESCHKE. U. S. 1,821,518, Sept. 1, 1931. An abrasive element for a grinding tool comprising, in combination, a base member having a channel-supporting face provided with apertures extending therefrom through the base member, an abrasive stone having a metal back plate adapted to seat within the channel of the base and upon the supporting face thereof and provided with threaded nipples receivable within the apertures of the base, and fastening means extending through the apertures in the base member and engaging the threaded nipples to secure the abrasive stone to the base member.

Trimming grinding wheels. JOHANNES WILBERZ. U. S. 1,822,073, Sept. 8, 1931. An apparatus for trimming grinding wheels comprising a frame, a slide adapted to reciprocate on the frame, a crank carried to rotate in the frame, a crank pin on the crank adapted to impart reciprocation to the slide, means for rotating the crank, means for varying its radius, a grinding wheel on the slide, and a trimming tool arranged on the frame in line with the grinding wheel.

Interior grinding machine for grinding out bores accurately. KARL JUNG. U. S. 1,822,222, Sept. 8, 1931. An internal grinding machine for accurately grinding out bores comprising a frame, a tool holder mounted on the frame and including a rotatable spindle having a grinding tool mounted thereon, a revolving head mounted on the frame, the head having a chuck for holding the work piece and a dressing device for the grinding tool, and means for revolving the head so that alternately a dressing of the grinding tool and a grinding of the bore of the work piece takes place, the holder and head being slidably arranged relative to each other.

Grinding machinery. JOHN E. CASTER. U. S. 1,822,337, Sept. 8, 1931. A centerless grinding machine including a grinding wheel, a regulating wheel, and a bracket intermediate the wheels, the grinding wheel being adapted to be rotated in the direction of the bracket at a high or grinding rate of speed and the regulating wheel being adapted to rotate with its operative face moving in a direction away from the bracket at its point of opposition to the grinding wheel, the bracket having a central recess to receive a work-rest member, a work rest adjustably mounted within the recess, the bracket extending laterally to one side of the wheels and terminating in a socketed portion, guide supports carried by the socketed portion, and work-engaging members mounted on the guide supports for supporting and guiding the work piece into the grinding throat.

Grinding machine. CECIL W. HOPKINS. U. S. 1,822,348, Sept. 8, 1931. In a centerless grinder the combination with a bed, a pair of opposed grinding and regulating wheels carried thereby forming a grinding throat therebetween, of a work-supporting mechanism positioned beneath the grinding throat useable during the performance of an in-feed grinding and a through-feed grinding operation and comprising a supporting

bracket, a work-rest blade carried by the bracket for supporting a work piece for peripheral rotation, arms pivotally carried by the bracket having a position adjacent the blade and a position remote from the blade, guide members removably carried by the arms, a shiftable plunger supported by the bracket and a detachable ejector mechanism carried by the bracket coöperating with the shiftable plunger for ejecting a work piece from the blade.

Abrasive compound. ROBERT S. LEATHER. U. S. 1,822,596, Sept. 8, 1931. A solid abrasive preparation comprising a mixture of glue, water, abrasive, and an agent which is physically associated with the glue for raising the softening temperature of the mixture, the preparation being readily transferable to a buffing or polishing implement by rubbing.

Portable grinding and resurfacing device. WILLIAM P. MEISSNER. U. S. 1,823,371, Sept. 15, 1931. A portable tool for grinding and resurfacing breaker points of a distributor without removing the points from the distributor casing, comprising a casing, a motor in the casing adapted to be operated from the ignition battery of an automobile, a radially disposed rib on one end wall of the casing, an arm extending forwardly from the rib and having a base portion directed along the rib and then terminally bent over the end of the rib, a screw detachably securing the end to the end of the rib, a shaft carried by the arm, a grinder disk supported by the arm and geared to one end of the shaft, and a shaft for the motor projecting through the end of the casing and having a terminal bearing receiving a squared end formed on the first-named shaft whereby removal of the screw permits disassembly of the arm and driving shaft from the casing and motor shaft.

Finishing and polishing machine. JOHN M. NASH. U. S. 1,823,625, Sept. 15, 1931. An attachment for a finishing and polishing machine, having means for rotating the work, the attachment comprising a guide for engaging the discharging end portion of a crooked piece of work, the guide having work-engaging members and adjusting means for adapting it to hold the engaged portion of the work to its natural annular path about the normal axial line of discharge until the work is wholly released from the machine.

Cleaning polishing wheels. JOHN J. CUNNINGHAM. U. S. 1,823,645, Sept. 15, 1931. In an apparatus for cleaning the cores of polishing wheels, etc., a casing to enclose a wheel having an outer portion which is to be removed, means for heating the article while it is within the casing to soften the outer portion, and means for rotating the wheel within the casing at a high speed to cause the softened portion thereof to be thrown off by centrifugal force.

Gear grinder, etc. ORLANDO GARRISON. U. S. 1,823,734, Sept. 15, 1931. A gear grinder including an arbor for supporting gears rotatably, a master gear operably associated with the arbor, a grinder wheel operable reciprocally to traverse the gear teeth in the axial plane of the gear, a carriage for moving the gears at right angles to their axial plane, a primary hydraulic motor for moving the carriage reciprocally, and a secondary hydraulic motor operably associated with the primary motor for indexing the gears upon completion of each reciprocation of the carriage.

Machine tool for dressing articles on nonparallel surfaces. ROBERT L. DYAS AND JOSEPH MAICKEL. U. S. 1,823,824, Sept. 15, 1931. In a machine of the class described, a plurality of arbors each having a cutting tool thereon, a chucking table for the article to be dressed, means to cause the chucking table to move past the arbors in a direction substantially at right angles thereto so that the tools may operate upon the articles, the arbors being located at different angles in planes transverse to the direction of movement of the table, a supporting device for the chucking table to permit a rocking movement of the table about an axis substantially at a right angle to the direction of

movement of the table and parallel to the planes, and means to hold the chucking table in a definite adjusted position in its passage beneath each arbor.

Centerless grinders. A. E. WHITE. Brit. 354,498, Aug. 19, 1931.

Twist-drill point grinding machines. R. STOCK & CO. SPIRALBOHRERWERKZEUG UND MASCHINENFABRIK AKT.-GES. Brit. 354,528, Aug. 19, 1931.

Centerless grinding machines. CINCINNATI GRINDERS, INC. Brit. 354,729, Aug. 26, 1931.

Art and Archaeology

Colemanite as glaze material. MYRTLE MERRITT FRENCH. *Jour. Amer. Ceram. Soc.*, **14** [10], 739–41 (1931).

Azurite glasses and glazes. E. BERDEL. *Keramos*, **10** [15], 385–88 (1931).—Copper oxide colors lead glass green and alkali glass blue. This blue does not contain any traces of green but is quite different from the cobalt blue.

$$\left.\begin{matrix}0.9\ Na_2O\\0.1\ CuO\end{matrix}\right\}\ 2\ SiO_2 \qquad (1)$$

The batch, 95.4 parts by weight of soda, calcined, 8.0 parts copper oxide, and 120.0 parts quartz sand, is mixed dry and fused in an oxidized atmosphere in a calcined refractory clay crucible. The fusion is crushed after cooling. The separate glass particles from the interior of the fusion are a bright blue, but if, at the beginning of the fusion, smoke and distillates appear producing reduction, the glass particles become red. This is avoided by using saltpeter.

$$\left.\begin{matrix}0.45\ K_2O\\0.45\ Na_2O\\0.10\ CuO\end{matrix}\right\}\ 2\ SiO \qquad (2)$$

The batch is as follows: 47.7 parts by weight of soda, calcined, 90.9 parts saltpeter powder, 8.0 parts copper oxide, and 120.0 parts quartz sand. Such azurite glasses are seldom used as glazes since they are easily decomposed and undergo great changes affecting their coloring during the firing of the glaze. With a small addition of lead oxide, the blue color of the glass is made purer and brighter, and the decomposability of the glaze lowered.

$$\left.\begin{matrix}0.40\ K_2O\\0.25\ Na_2O\\0.25\ PbO\\0.10\ CuO\end{matrix}\right\}\ 2.0\ SiO \qquad (3)$$

The batch consists of 80.8 parts by weight of saltpeter powder, 26.5 parts soda, calcined, 34.4 parts minium, 8.0 parts copper oxide, and 120.0 parts quartz sand. The glass particles obtained show the most beautiful and brightest azurite. This color is dependent on a sharp oxidized firing. The blue color is shaded off to green by (1) lead oxide if it amounts to over 0.25 PbO, (2) lime, (3) alumina, and (4) boric acid. Grinding batches rich in alkali with oil or alcohol is recommended as such glazes are very sensitive during firing and produce fine cracks on the surface. The alkali glazes have a large coefficient of expansion and therefore it is seldom that turquoise glazes are without cracks. This can be avoided by a high glaze firing and increase in the silicic acid content. An addition of magnesite or magnesium silicate (steatite) is also good. Failures to obtain a pure azurite glaze are generally due to the composition of the body of the ware. Its alumina content affects the color of the glaze, and it must be absolutely free from lime and as dense as possible. The length of firing also affects the coloring. M.V.K.

Color-matching machine. ANON. *Instrument World*, **4**, 18 (1931).—The machine consists essentially of two photoelectric cells in front of which are placed the samples.

Variations in shade are reproduced as galvanometer deflections and the difference may be determined by color filters. H.H.S.

Colors. NAN HORNBECK. *Factory & Ind. Management*, **82** [3], 344–45 (1931).—An analysis of color for decorating different products to stimulate the appeal of the product is presented. E.C.C.

Suggestions on color in display. ANON. *Pottery Gaz.*, **56** [651], 1263–66 (1931).—Varicolored pottery generally has one more or less decided color that creates a greater impression than the others and in the display a foil must be provided by using a number of pieces of a definite color or of one tint or tone. Colors are successful according to the situation in which they are placed with regard to others. Simple examples of contrasts, an experiment with complementary colors, and secondary and tertiary colors are discussed in some detail. Manipulation of colors in window displays is discussed. Illustrated. E.J.V.

Decorated "faiences" from Sèvres. RENÉ CHAVANCE. *Art et Déc.*, pp. 151–56 (May, 1931).—A new clay body called "grès fin" can be turned, poured, or molded. It fires a dark buff. Sèvres is producing, through Plantard, Naudy, Mlle. Richard, and Gensoli, vases sober and robust in shape with suitable conventional designs. They are warm in color on a plain background. This modern movement is criticized by Jean Laquin, who believes that Sèvres has lost its style which was a part of the art of the 18th Century. Illustrated. M.J.G.W.

Gullaskruf glass. I. E. TROMM. *Sprechsaal*, **64** [35], 648–49 (1931).—Some samples of Gullaskruf glass are shown which are beautiful and peculiar in design. W.M.C.

Luster ware of England. L. L. *Christian Sci. Mon.*, **23** [239], 11 (1931).—The names of many potters prominent in the Staffordshire, Leeds, Swansea, Sunderland, and other potting districts of England are associated with the manufacture of luster ware, but so few pieces were marked that it is difficult to assign most of it definitely to a particular maker. The lustrous effects are due to the application of a metallic oxide glaze. A solution of platinum is used in the production of silver luster and the copper and gold or purple lusters are due principally to copper. The color and texture of the clay body, the strength of the oxide, and the firing influence the color. The most prized form of luster ware is known as "resist." This method of decorating consists in painting the design on a carefully prepared plain ground with a substance easily soluble in water, *e.g.*, glycerine, and then covering the piece with luster glaze. The glycerine prevents the luster from adhering and is easily washed away leaving the design in the ground color, the luster forming the background. Panels and bands may also be reserved in this way. Wedgwood produced some exquisite colorings in gold, pink, lilac, and purple luster, including a ruby tint, principally, no doubt, from a copper oxide. Illustrated. E.J.V.

Translucent crystal animals by Georges Chevalier. G. PASCAL. *Mobilier et Déc.*, pp. 159–63 (April, 1931).—The amusing spontaneity of animal figures in gleaming crystal designed by Chevalier bestow a gay touch to the primness of modern interiors. (*D.I.*)

Pets of porcelain. GOLDA GOLDMAN. *Ceram. Age*, **17** [6], 316–19 (1931).—G. describes a few of the best known animal figures executed in porcelain. Illustrated. R.G.M.

Eternal forms. W. LOTZ, W. RIESLER, AND JUSTUS BIER. *Form*, pp. 161–75 (May 15, 1931).—Three articles are given about a recent exhibit in Munich, Germany, based on the "eternity" of forms and shapes in pottery, glass, ceramics, nature, industry, etc. Opposition to the idea expressed in this exhibit is presented by W. Lotz who emphasizes diversity of shapes and forms according to surroundings, age, period, material, etc. (*D.I.*)

Influence of Austrian art on German stove building. M. BIRKENBIHL. *Sprechsaal*, **64** [24], 449–52 (1931).—Many old stoves in residences, etc., show the high art of building furnaces. Illustrated. W.M.C.

Painted glassware. ANON. *Christian Sci. Mon.*, **23** [226], 5 (1931).—The production of painted glassware for use in home decoration by painting designs on clear and colored glass pieces with liquid enamels is discussed. Some of the effective color combinations are enumerated. Commercial products of this sort are also obtainable. Illustrated. E.J.V.

New method of lighting. ANON. *Art et Déc.*, p. 6 (Jan., 1931).—A new idea of lighting is embodied in the "Atrax cube" which consists of a crystal square lined with opalescent glass, blown in one piece in a mold. It can be used for interior or outside lighting and may be colored. Illustrated. M.J.G.W.

Art and industry. CLAUDE BRAGDON AND CLEOME CARROLL. *Outlook & Independent*, pp. 176–78 (June 10, 1931). (*D.I.*)

Art as a selling point. LEW HAHN. *Amer. Mag. Art*, pp. 40–48 (July, 1931).—No merchant can now depend on "staples" for all goods are sold as much by their design as by their quality. An era of prosperity has helped in educating the public taste to demand good design. (*D.I.*)

Craftsmanship in decorated glass. EUGENE CLUTE. *Architecture*, pp. 11–16 (July, 1931).—An explanation of the qualities of Maurice Heaton's glass work is given as well as the method of production and its commercial use. (*D.I.*)

Frederick Carder. LUCY M. MALTBY. *Cleveland Plain Dealer*, **90**, No. 242 (1931).—Carder, art director of the Steuben Division of the Corning Glass Works, worked as an apprentice in his grandfather's pottery in England for three years before he became interested in glassmaking and obtained a position as designer in a glass factory. At the age of seventeen he began work on colored glasses, then obtainable in England by importation, and as a result of his experiments, colored glassware was introduced in England. In 1903 he came to America and founded the Steuben Glass Works, which has since been taken over by the Corning Glass Works. The process of making handmade glassware is briefly described. The new Itarsia glass, recently developed by Carder, has traceries of amethyst, blue, or black on crystal, and every piece is "signed" by him, having his signature engraved on it. Illustrated. E.J.V.

André Hunebelle. NIM FRANK. *Art et Déc.*, pp. 51–58 (Feb., 1931).—The style of Hunebelle is the outcome of three years' work in glass paste, using geometrical designs on mathematical lines for modern tastes. His work is reproduced in limited quantities. Illustrated. See also *Ceram. Abs.*, **10** [5], 324 (1931). M.J.G.W.

Modern ceramic and glass art at the 23rd Paris fair. ANON. *Sprechsaal*, **64** [33], 611 (1931). W.M.C.

Fifth exhibition of contemporary French decorators. PIERRE MIGENNES. *Art et Déc.*, pp. 91–96 (March, 1931).—Lighting effects are displayed in the Rue des Industries d'Art, Paris. At the Pavillon de Marsan examples of plates by Gaston Laurin, figures by Nelly Pallak, glass by Cardulhac, etc., are shown. Illustrated. M.J.G.W.

Glassware and flowers of René Lalique. ANON. *Art et Déc.*, pp. 6–7 (June, 1931).—Lalique exhibits realistic flowers for table decoration in the Spring Salon. Illustrated. See also *Ceram. Abs.*, **10** [10], 676 (1931). M.J.G.W.

Engraved glass of Étienne Couruault. ROGER BRIELLE. *Art et Déc.*, pp. 121–28 (April, 1931).—Purely decorative engraved glass, ultra-modern in design, is said to produce interesting light effects. Mysterious paintings are made on glass with the aid of mirrors. The first exhibition of this glass was held at Nancy. Illustrated. M.J.G.W.

Twenty-first Salon des Artistes Decorateurs. ANON. *Art et Déc.*, pp. 5–19 (July,

1931).—Engraved glass by Pierre Lardin, ceramics by René Ruthard and Saint Leu, glass by Marinot and P. Gaillard, and glass service by Marcel Goupy are exhibited. Illustrated. See also *Ceram. Abs.*, **10** [7], 477 (1931). M.J.G.W.

Arts of early American Indians. ANON. *Christian Sci. Mon.*, **23** [227], 11 (1931).—A description is given of some of the clay vessels, bottles, ornaments, pans, etc., in the Clarence B. Moore collection at the Museum of the American Indian, Heye Foundation, New York. This collection represents the art of the Indians from southeastern America and includes about 13,500 specimens. Illustrated. See also *Ceram. Abs.*, **8** [9], 624 (1929). E.J.V.

Roman pottery. ANON. *Christian Sci. Mon.*, **23** [205], 4 (1931).—Old Roman pottery and glass have been found near Ospringe, Kent, England. A museum of Roman pottery and glass has been formed of the specimens that have been found. Illustrated. E.J.V.

Agrigentum discoveries. P. MARCONI. *Illus. London News*, **178,** 959–61 (1931).—A plastic vase, the figure of a mule, is regarded as the greatest find at the sanctuary of the earth goddesses at Akragas. See also *Ceram. Abs.*, **10** [7], 479 (1931). H.H.S.

Art of mosaic in Ancient Greece. T. L. SHEAR. *Illus. London News*, **178,** 1012 (1931).—Colored reproductions of mosaic from pre-Christian Corinth are described. H.H.S.

Zimbabwe ruins. P. S. NAZAROFF. *Blackwood's Mag.*, **229,** 765–92 (1931).—The mysterious ruins in Rhodesia possess the peculiarity of a total absence of roofs. N. deduces that they were places for the disposal of the dead by vultures of the air. The fragments of Nankin china, etc., found in the ruins were brought by later peoples. H.H.S.

Handicrafts of Cyprus. JAMES HORNELL. *Discovery*, **12,** 187–90 (1931).—A kiln and an open-air potters' store are illustrated. H.H.S.

Chinese pottery. J. LYMAN SHEEAN. *Jour. Chem. Ed.*, **8,** 1249–66 (1931); for abstract see *Ceram. Abs.*, **10** [3], 168 (1931). (*C.A.*)

BOOKS

Archaeology of the Arkansas River Valley. W. K. MOOREHEAD. x + 205 pp. Yale Univ. Press, New Haven, 1931. Published for the Phillips Academy, Andover, Mass. Price $4.50. Reviewed in *Times Lit. Supp.*, **30,** 511 (1931).—This book contains supplementary papers on the prehistoric culture of Okla., by J. B. Thorburn, and the exploration of Jacobs Cavern, by C. Peabody. H.H.S.

Greek Cities in Italy and Sicily. D. R. MACIVER. xii + 226 pp., 22 plates. Clarrendon Press, Oxford, 1921. Price 12s 6d. Reviewed in *Times Lit. Supp.*, **30,** 485 (1931).—The cities of greater Greece have some of the best monuments of ancient Hellenic culture. H.H.S.

Necrocorinthia. HUMFRY PAYNE. Oxford Univ. Press, 1931. Price 4 guineas. Reviewed in *Discovery*, **12,** 234–35 (1931).—The Director of the British School at Athens embodies the results of research in the ceramic and other arts of Corinth in the archaic period. H.H.S.

PATENTS

Design for glass jar. HARRY R. MCDONALD. U. S. 84,948, Aug. 25, 1931. WALTER R. STERRETT. U. S. 85,067, Sept. 8, 1931.

Design for lamp globe. JOSEPH H. ALLEN. U. S. 84,911 to 84,913, Aug. 25, 1931.

Design for lantern. JOSEPH H. ALLEN. U. S. 84,914, Aug. 25, 1931.

Design for water-closet bowl. GEORGE BRAIN. U. S. 84,973 and 84,974, Sept. 1, 1931.

Design for cover glass lens for headlights. GUSTAVE ALPHONSE MARIE LAMBLIN-PARENT. U. S. 84,991 to 84,994, Sept. 1, 1931.

Design for plate, etc. GEORGE WESP. U. S. 85,020 to 85,023, Sept. 1, 1931. WALTER S. MAYER. U. S. 85,111, Sept. 15, 1931. CHARLES O. SMITH. U. S. 85,123, Sept. 15, 1931.

Design for bottle, etc. CHAUNCEY W. B. HUGHES. U. S. 85,044, Sept. 8, 1931. JEAN W. BICKS. U. S. 85,081, Sept. 15, 1931. ERNEST E. BILBY. U. S. 85,082, Sept. 15, 1931. GEORGE N. MAS. U. S. 85,109, Sept. 15, 1931.

Design for light shade, etc. NICHOLAS KOPP. U. S. 85,049, Sept. 8, 1931.

Design for teapot, etc. WALTER LINDLEY. U. S. 85,050, Sept. 8, 1931.

Design for bathtub. GEORGE SAKIER. U. S. 85,061, Sept. 8, 1931.

Design for bowl, etc. EUGENE STAHL. U. S. 85,064, Sept. 8, 1931. GEORGE BECKER. U. S. 85,080, Sept. 15, 1931.

Design for candlestick, etc. EUGENE STAHL. U. S. 85,065, Sept. 8, 1931.

Design for pitcher, etc. EDWARD E. BARTLETT. U. S. 85,077, Sept. 15, 1931.

Design for goblet, etc. GEORGE BECKER. U. S. 85,079, Sept. 15, 1931.

Design for drinking glass. CHARLES FLETCHER. U. S. 85,091, Sept. 15, 1931.

Design for stove. FREDERICK W. CUFFE. U. S. 85,088, Sept. 15, 1931. HENRY C. MAUL. U. S. 85,110, Sept. 15, 1931. ARTHUR STOCKSTROM. U. S. 85,129 and 85,132, Sept. 15, 1931.

Design for combination soap dish and handrail. AUGUST J. SMITH. U. S. 85,122, Sept. 15, 1931.

Design for sheet glass. FRED F. SHETTERLY. U. S. 85,118, Sept. 15, 1931.

Design for set of range doors. ARTHUR STOCKSTROM. U. S. 85,126 and 85,127, Sept. 15, 1931.

Design for range door. ARTHUR STOCKSTROM. U. S. 85,128 to 85,131, Sept. 15, 1931.

Design for water-closet flush tank. BERT O. TILDEN. U. S. 85,137, Sept. 15, 1931.

Stencil for decorating chinaware and pottery. GEORGE A. BAUER. U. S. 1,822,986, Sept. 15, 1931. A stencil for decorating chinaware and pottery, comprising a pattern formed of lead or other suitable pliable material, a reinforcing ring extending around the entire outer edge of the pattern, and lugs projecting upwardly from the ring on opposite sides thereof.

Coating ceramic or metal ware. SFINX, SPOJENÉ SMALTOVNY A TOVARNY NA KOVOVÉ ZBOZI, AKC. SPOL. Brit. 343,640, Dec. 15, 1928. The ware is decorated by spraying coloring matter over or through a screen which is perpendicular to the surface to be treated, at an oblique angle to both the screen and the surface. Apparatus and details of operation are described. (*C.A.*)

Gold preparation for decoration of porcelain or glass. KO NAKATUTI. Japan 90,288, Feb. 16, 1931. An essential oil containing an unsaturated alcohol or ester, *e.g.*, terpineol, geraniol, linaloöl, or their acetates, is heated with S. Balsam monosulphide thus prepared is purified by distillation at 120 to 30° under 20 mm. pressure. It is then made to react with 10% aqueous solution of $AuCl_3$, purified, and mixed with resinates of Bi, Rh, and Cr. The product is dissolved in a mixture of rosemary oil and $PhNO_2$. (*C.A.*)

Cement, Lime, and Plaster

Differentiation of qualities of cement. S. GIERTZ-HEDSTRÖM AND DONAVAN WERNER. *Zement*, **20** [10], 213–15 (1931); *Rock Prod.*, **34** [17], 86 (1931).—The cement industry has been standardized but not suitably specialized. Portland, iron Portland,

blast furnace, French grappier, soliditit, pozzuolana, aluminate, and ore cement are required to be applicable for identical purposes and in an identical manner. Rational specialization on the basis of special qualities for special purposes is sought. Cements for marine construction and for surface construction are desired. The latter show decreased shrinkage, quicker hardening, and greater strength, and also increased solubility and greater generation of heat in hardening. The marine construction cement should show less solubility, less heat in hardening, possibly greater shrinkage, slower hardening, and lower strengths. W.W.M.

Cement in theory and practice. HANS KÜHL. *Pit & Quarry*, **22** [11], 77 (1931); for abstract see *Ceram. Abs.*, **10** [8], 544 (1931). E.P.R.

Effect of storage upon fineness, setting, and strength properties of Portland cement. ALTON J. BLANK. *Rock Prod.*, **34** [17], 62–64 (1931).—B. tested 18 cements. Fineness as a rule increased with storage up to three months. In most cases the initial and final set was retarded with increased storage. All cements increased in tensile strength with storage, varying from 24 hours to one month, when the strength declined. No conclusions are drawn. W.W.M.

Modern methods of determination applied to the analysis of cement. ÉTIENNE RENGADE. *Rev. mat. constr. trav. pub.*, No. 262, pp. 265–68(1931).—The following methods were presented before the French Association for Testing Materials: (1) methods founded on the use of special indicators: (*a*) precipitation of the sesquioxides, (*b*) rapid determination of magnesia in limestones; (2) accelerated determination of silica by the use of perchloric acid; (3) determination of iron by the use of titanous chloride; (4) determination of manganese (and eventually of chromium) by the Smith-Travers method; and (5) determination of free lime in cements by the method of Lerch and Bogue (see *Ceram. Abs.*, **10** [4], 304 (1931)). M.Y.H.

Researches on the rotary kiln in cement manufacture. XXIV. GEOFFREY MARTIN. *Rock Prod.*, **34** [17], 30–32 (1931).—M. shows the method of calculating the maximum amount of water which can be retained in the slurry without increasing fuel consumption. This calculation is based on the lowest practical exit gas temperature of 212°F. A table is given showing the operating characteristics under varying kiln conditions. **XXV.** *Ibid.*, **34** [18], 22–24 (1931).—Calculations are made of the amount of water which can be retained in the slurry to produce a specific output of clinker per pound of coal burned and still keep the exit gases at the lowest possible temperature to get rid of the steam, allowing for external radiation losses of an amount which occurs in actual practice. Tabulated data of results of computations for a wide range of operating conditions are given. For Part XXIII see *Ceram. Abs.*, **10** [10], 680 (1931). W.W.M.

Vertical shaft kilns for high-grade cement. AUGUSTO BUES. *Cemento*, **3** [7], 225–33 (1931); *Pit & Quarry*, **22** [10], 70 (1931).—There is a widespread and unjust tendency to consider cement made in shaft kilns inferior in strength and quality to cement made in rotary kilns. E.P.R.

Arsenious cement of low solubility. DONAVAN WERNER AND S. GIERTZ-HEDSTRÖM. *Zement*, **20** [4], 384–88 (1931); *Pit & Quarry*, **22** [10], 70 (1931).—At the laboratory of the College of Engineering at Stockholm, investigations have been under way for about two years to meet the existing demands of modern concrete practice through a rational specialization of cement manufacture. These researches, which are based on mechanical as well as on physico-chemical studies, have in view, among other things, the production of a cement characterized by low solubility and thus particularly suited for construction in water. A contribution to this investigation is the research on the effect of arsenic trioxide on Portland cement. It has been shown that a mixed cement, containing 30% of As_2O_3 and 70% of standard Portland cement, has a short

setting time (about 5 min.). The compressive and tensile strengths of mixed cements with varying content of arsenic trioxide fall with the first addition of the arsenic trioxide to a minimum when the admixture is at 10 to 15%, after which the strength rises again to a maximum when the content of As_2O_3 is 30%, at which the strength is somewhat lower than in the case of pure Portland cement. With arsenic trioxide content higher than 30% the strength falls rapidly. The lime solubility of the Portland cement is decreased through addition of arsenic trioxide. The lowest solubility is at 30 to 40% admixture of As_2O_3 and 70 to 60% Portland cement, and is somewhat dependent on the age of the materials when used. E.P.R.

White cement. ANON. *Tonind.-Ztg.*, **55** [64], 922–23 (1931).—The production of white cement is only possible with pure raw materials together with a special type of clinkering and some other means which are said to be kept secret by the manufacturers. W.M.C.

Evaluation of Portland cement by particle-size determination. S. DICKSON. *Chem. & Ind.*, **50** [32], 295–96 (1931).—By liquid elutriation, the particle size of Portland cement can be graded and the differentiation between a good cement and one which is not so good becomes possible. G.R.S.

Kiln design for production of fused cement. E. SCHIRM. *Pit & Quarry*, **22** [10], 57–62 (1931); for abstract see *Ceram. Abs.*, **10** [10], 680 (1931). E.P.R.

Repeated setting of cement. K. A. GOSLICH. *Tonind.-Ztg.*, **55** [68], 969–70 (1931).—Experiments have shown that a cement which has set once will set again when ground together with fresh clinkers. This is important in connection with cement which has become wet. W.M.C.

Proposed German specifications for alumina cement. HUGO VIERHELLER. *Rock Prod.*, **34** [17], 86 (1931); for abstract see *Ceram. Abs.*, **10** [8], 544 (1931). W.W.M.

Effect of magnesia on alumina and Portland cements. H. LUFTSCHITZ. *Rock Prod.*, **34** [17], 86 (1931); for abstract see *Ceram. Abs.*, **9** [10], 822 (1930). W.W.M.

Fine grinding and strength of cements. W. WEISGERBER. *Tonind.-Ztg.*, **55** [65], 933–35; [66], 946–47 (1931).—The deductions of Kühl and others, that fine grinding may improve the strength of cements, are discussed. According to experiments the amount of water added to the cement must also be brought into consideration. A cement should have not only a high strength but also the property to become fluid with as little water addition as possible. W.M.C.

Plaster for molds. ANON. *Brit. Clayworker*, **40** [472], 185–86 (1931).—Of several kinds of plaster, only superfine plaster of Paris is suitable for making terra cotta, sanitary ware, and other pottery molds. Methods of mixing are given. R.A.H.

Gypsum and the semihydrated sulphate of lime. R. NACKEN AND K. FILL. *Tonind.-Ztg.*, **55** [61], 885–88; [62], 902–904; [63], 913–15 (1931).—This paper is abstracted from a book on the same subject and by the same authors. It gives a critical study of the literature on the formation of gypsum and semihydrated sulphate, together with some heating curves. W.M.C.

PATENT

Manufacture of imitation marble. S. GAUDIO. Brit. 349,485, Jan. 27, 1930. Slabs, etc., prepared by the setting of plastic mixtures comprising "Keen's superfine white cement," marble or alabaster powder, CaO, alum, and H_2O with the addition, if desired, of colors, are immersed in H_2O on the surface of which a linseed oil-turpentine color solution is floated and stirred to give a stripe effect to the slabs. After removal and drying, the slabs are steeped successively in oil, in liquid bronze, and in lacquer, and are finally wax-polished. (*B.C.A.*)

Enamels

Mechanics of enamel adherence. I. Technique of preparing enamel metal sections for microscopic analysis. J. O. LORD AND W. C. RUECKEL. *Jour. Amer. Ceram. Soc.*, **14** [10], 777–81 (1931). **II. Effect of composition and firing atmospheres on the adherence of ground-coat enamels.** WALTER C. RUECKEL AND R. M. KING. *Ibid.*, **14** [10], 782–88 (1931). **III. Enamels on copper: the nature of their adherence.** W. K. CARTER AND R. M. KING. *Ibid.*, **14** [10], 788–94 (1931); also abstracted in O. S. U. *Eng. Expt. Sta. News*, **3** [3], 2 (1931); *Ceram. Ind.*, **17** [2], 117 (1931).

Expansion of enamels. L. STUCKERT. *Ceram. Age*, **17** [5], 269–72 (1931).—S. discusses expansion and thermal resistance of enamels. Expansion factors found by various authors are tabulated. The variations and discrepancies appearing in the results are discussed. Kinzie's apparatus for testing resistance to thermal shock is illustrated. R.G.M.

Strains in enamels and their mechanical resistance. R. THILENIUS. *Ceram. Age*, **17** [6], 309–13 (1931).—T. analyzes the forces which determine the mechanical resistance of porcelain enamels. The introduction of a coefficient of mechanical resistance for enamel glazes is advocated. R.G.M.

Optical properties of enamels. L. STUCKERT. *Ceram. Age*, **18** [1], 22–26 (1931).—The average index of refraction of the glasses upon which enamels are based lies approximately at the value 1.50 to 1.55. The index of refraction is important with reference to the luster and opacity of enamels. The four following types of opacification are found: (1) opacity caused by insoluble components embedded in the batch which have higher exponents of light refraction, (2) devitrification, the separation of single materials from the glass melt, (3) a form based on the nonmiscibility of the components at different temperatures, and (4) that type which results from the presence of a dispersed phase consisting of the most minute gas bubbles in the melt. Opacifiers possess two physical characteristics: (1) their indices of refraction are either larger or smaller than that of the melt, and (2) they have either the lowest possible solubility in the melt when finely divided, or those portions which are in solution at higher temperatures separate out as completely as possible on cooling. The nature of gas bubbles, time factor, and opacity of colored enamels are discussed. R.G.M.

Tin oxide substitute for enamels. ANON. *Glashütte*, **60**, 549 (1930).—The advantages were given of the oldest of these, *viz.*, sodium meta-antimonate, which was sold under the trade name "Leukonin." It could be substituted for tin oxide as an opacifier in powder form without other modification of the recipe or detriment to the glass, fusibility, thermal endurance, or durability. It was more effective and gave better quality enamel for certain purposes than cryolite. (*J.S.G.T.*)

Producing a white opacifying agent for enamels and glasses. VEREINIGTE CHEMISCHE FABRIKEN KREIDL HELLER & CO. *Emailletechnische Monats-Blätter*, **7** [4], 39 (1931).—A white opacifying agent is produced by mixing titanium oxide and cerium oxide with alumina, kaolin, quartz, the colorless oxides of the rare earths, tin oxide, zircon dioxide, antimony oxide, or niobium oxide, and sintering it at a high temperature. E.J.V.

Deckborolith. ANON. *Emailletechnische Monats-Blätter*, **7** [8], 89 (1931).—Deckborolith is a commercial product used as an opacifier in white cover-coat enamels, which increases the glossiness and the covering power of the enamels and permits a decreased mill addition of tin oxide. Its properties are enumerated. E.J.V.

Acid inhibitors in the pickling of metals. GEORGES BATTA AND EDM. LECLERC. *Chim. & Ind.* [Special No.], pp. 475–83 (March, 1931).—The results obtained by adding various inhibitors (gelatin, CH_2O, flour, Na_2AsO_3, anthracene oil from coke ovens, and 2 commercial products) to a 20% HCl bath and a 10% H_2SO_4 bath are described. The

method used consisted in measuring the volume of H evolved on immersing cleaned sheets of the metal for a given time in the pickling bath, and was found satisfactory for comparative purposes. The cleaning of the metal surface before the test considerably affects the results, a much greater evolution of H being obtained by polishing the surface than by cleaning with acid, H_2O, and Et_2O, which is attributed to some of the H remaining occluded to the surface of the acid-cleaned metal. In every case, addition of inhibitor reduced the surface tension of the bath. The value of an acid inhibitor can be determined to a satisfactory degree of approximation by the following tests: (1) determination of retardation in the solution of the metal by (*a*) comparing the losses in weight of identical samples of metal to be treated under the same conditions, in presence and absence of the required amount of inhibitor, or (*b*) by comparing the volume of H evolved; (2) pickling tests consisting in immersing tared unpickled samples in baths with and without inhibitor and comparing (*a*) loss in weight, (*b*) time required for pickling, (*c*) number of samples which can be pickled in a given volume of bath, and (*d*) appearance of the pickled metal; (3) determination of resistance of the inhibitor to the action of hot concentrated solutions by heating the bath 6 to 12 hr. and then determining the volume of H evolved with a standard sample of the metal. (*C.A.*)

Degreasing and cleaning metal parts. A. Burg. *Emailletechnische Monats-Blätter*, **7** [5], 51–54 (1931).—In preparing metal pieces for enameling it is necessary to degrease and clean the surface thoroughly. An annealing process is used to burn off the oil and grease picked up during the working of the piece or it is cleaned chemically by treating it in baths of organic or inorganic solvents. The latter are divided into three classes, solvents, emulsifying, and saponifying chemicals. The various chemicals that fall into these three classes are enumerated and their respective efficiencies discussed. Some commercial metal cleaners are also described. E.J.V.

Equipment for cleaning metal. VIII. R. W. Mitchell. *Metal Cleaning & Finishing*, **3** [8], 631–34 (1931).—Considerable data are presented on heat losses from tank surfaces, radiating power of surfaces, and the heat conductivity of various materials. Tables for the calculation of heat losses from metal surfaces covered with various thicknesses of insulation are included. Illustrated. For Part VII see *Ceram. Abs.*, **10** [10], 682 (1931). E.J.V.

Alkali solutions as metal cleaners. C. L. Mantell. *Metal Cleaning & Finishing*, **3** [8], 641–45 (1931).—The relation between p_H, ionization, concentration, and temperature of alkali solution containing only caustic, soda ash, ammonia, and combinations of these is pointed out. That such solutions have limited application for cleaning purposes is one of the points stressed. See also *Ceram. Abs.*, **10** [7], 484 (1931). E.J.V.

Development of vitreous enameling. Matthew W. Butler. *Emaillewaren-Ind.*, **8** [27], 213 (1931); for abstract see *Ceram. Abs.*, **10** [6], 412 (1931). M.V.K.

Enameling process in a cooking ware plant. Thomas Davies. *Ceram. Ind.*, **17** [3], 185–88 (1931).—D. describes the cooking ware plant of the Coonley Mfg. Co., and gives formulas for twelve ground coats, one coat, and finish enamels and describes their preparation. Pickling practice, including formulas of solutions, is described in detail. All enamel is applied by dipping and the beading enamels are applied with the fingers. Methods of thickening the enamel and beading slips when too thin, and of producing a mottled effect in gray are described. First-coat enamels are fired at 1540°F and cover coats at 1430°F. W.W.M.

Oriental enameling methods. J. W. Wolfe. *Emaillewaren-Ind.*, **8** [27], 213 (1931); for abstract see *Ceram. Abs.*, **10** [6], 412 (1931). M.V.K.

Enameling automobile exhaust pipes. Anon. *Emaillewaren-Ind.*, **8** [27], 210 (1931).—A description of enameling of automobile exhaust pipes by German automobile manufacturers and requirements set for such an enamel are given. M.V.K.

Rational manufacture of buckets. ANON. *Emaillewaren-Ind.*, **8** [28], 218–19 (1931).—Methods used for the manufacture of enameled buckets are discussed. M.V.K.

Enameling mechanized. W O. OWEN. *Ceram. Age*, **18** [1], 15–17 (1931).—One of the latest and most economical installations for applying and firing vitreous enamel is a furnace with two overhead traveling conveyers which extend through the unit and loop back on the outside. The dipping, spraying, drying, and brushing units are placed along the exposed portions of the conveyers. The furnace of the Peerless Enamel Products Co., Belleville, Ill., is described. Illustrated. R.G.M.

Efficiency of combustion in oil-fired enameling furnaces. EMERSON P. POSTE. *Ceram. Ind.*, **17** [3], 201–205 (1931).—P. investigated the efficiency of three types of oil-burning furnaces, made flue-gas analyses, and compared them with the theoretical products of combustion of the fuel in use. The furnaces were (1) a rotary smelter, (2) a sheet-iron furnace without recuperator, and (3) a cast-iron furnace with recuperator. Using the ratio of the air required to the theoretical amount of air as an index of efficiency, the smelter was found to be most efficient with an air ratio of 1.2. The best obtainable air ratio with the cast-iron furnace was 1.6 and with the sheet-iron furnace, 1.3. Variations in oil pressure and stack draft affected the efficiency of combustion. Since enamels require an oxidizing atmosphere, the efficiency of combustion is limited by the danger of the presence of CO and absence of O_2. The tests made indicate that a CO_2 content of from 8 to 11% should be possible, giving air ratios of from 1.9 to 1.4 under ordinary operating conditions. W.W.M.

Shipping-room losses. HENRY PHILLIP. *Ceram. Ind.*, **17** [3], 188 (1931).—P. believes in standardized millroom practice. Ten factors are presented which should be observed to keep shipping-room losses as low as possible. W.W.M.

BOOK

Nonmetallic Inclusions in Iron and Steel. CARL BENEDICKS AND H. LOFGUIST. Chapman and Hall, Ltd., London. Price 30s net. Reviewed in *Engineering*, **131** [3415], 819 (1931). A.A.

PATENTS

Electric smelting apparatus and process. ALBERT E. GREENE. U. S. 1,819,239, Aug. 18, 1931. In the operation of a smelting furnace combining fuel combustion and electric heating, the process which consists in adding coal in proximity to the electric arc whereby the ingredients of the coal are broken up and subsequently admitting air to burn these ingredients in the same furnace chamber.

Enameling-furnace conveyer. ROBERT MACDOUGALL. U. S. 1,819,472, Aug. 18, 1931. In apparatus of the class described and having a heating passage and a metal-link conveyer chain equipped with suspension rods extending downwardly into the passage, means for suspending articles through the rods including spacing links flexibly connecting the lower ends of the rods, transversely disposed skeleton box frames also flexibly connected to the rods, and tool frames extending across spaces between the box frames and connected adjacent opposite ends to a pair of such frames.

Art of making enamelware. OSCAR HOMMEL. U. S. 1,819,816, Aug. 18, 1931. In the manufacture of enamelware the method which consists in applying to the surface of a body of iron or steel a solution of an adhesive in association with a metallic salt, drying the so-treated body, applying to the surface of the dried body enamel material, and firing.

Hanger for continuous enameling furnaces. JOHN O'FALLON CLARK. U. S. 1,822,012, Sept. 8, 1931. A hanger arm for conveyers comprising a short inserting portion adapted to pass through an opening in a supporting member, and shoulders on

the inserting portion spaced apart to bring them, when the arm is inserted, on opposite sides of and, respectively, above and below the opening, the arm having a portion extending downwardly so low and so close to the inserting portion that a force exerted in a single direction on the downwardly extending portion will dislodge the arm.

Detergents for metal surfaces. C. F. DINLEY. Brit. 340,323, Sept. 28, 1929. Rust and oil are removed from metal surfaces by applying an aqueous paste comprising (1) a rust-removing acid such as H_3PO_4, oxalic, acetic, tartaric, or citric acid or a mixture of H_2SO_4 and tannic acid, (2) a liquid organic oil and grease-solvent such as an alcohol, ketone, ester, or aromatic hydrocarbon, and (3) finely divided inert mineral matter such as cryolite, silica, alumina, talc, fuller's earth, kaolin, or fluorspar. The composition is dried on the metal until it is friable and then removed. Metal salts such as ferric phosphate also may be added. See following patent. (*C.A.*)

Cleaning metal surfaces. C. F. DINLEY. Brit. 340,047, Sept. 28, 1929. Rust and oil, etc., are removed from metal surfaces such as those of vehicle bodies by the use of rust solvents, *e.g.*, phosphoric, selenic, oxalic, acetic, tartaric, or citric acids, together with a compatible oil and grease solvent such as alcohols, ketones such as Et Me ketone or esters, and a thickening agent such as raw sienna or metallic oxides (ferric or Mn oxides) which is inert at ordinary temperature but reacts with the rust solvent on heating or drying and thus renders the composition friable and "self-peeling." A pigment such as willow charcoal or lampblack may also be added. (*C.A.*)

Furnaces for firing enamelware. NAAMLOOZE VENNOOTSCHAP FERRO ENAMELING CO. OF HOLLAND. Brit. 353,976, Aug. 12, 1931; see also *Ceram. Abs.*, **10** [10], 683 (1931).

Enamels. DEUTSCHE GOLD- UND SILBER-SCHEIDEANSTALT VORM. ROESSLER. Brit. 354,362, Aug. 19, 1931; see also *Ceram. Abs.*, **10** [8], 550 (1931).

Glass

Variations in heating curves of glass caused by heat treatment. A. Q. TOOL AND C. G. EICHLIN. *Ceram. Ind.*, **17** [3], 218–22 (1931); for abstract see *Ceram. Abs.*, **10** [8], 554 (1931). W.W.M.

Rational production of flashed opal and colored glass. W. MEWES. *Glashütte*, **60**, 826 (1930).—The following batches are given for the production of opal flashing and base glasses of linear thermal expansion coefficient 77 to 78.1 × 10^{-7}.

	Batches					Glasses (calculated)			
	1		2			1		2	
	Opal	Crystal	Opal	Crystal		Opal	Crystal	Opal	Crystal
Sand	100	100	100	100	SiO_2	76.83	79.16	76.58	79.13
Cryolite	10		12		F_2	3.30		3.95	
Borax			1	1	Al_2O_3	1.88		2.25	
Soda (98%)	14	17	19	21	B_2O_3			0.36	0.36
Potash (98%)	9	15	5	10	Na_2O	9.50	7.64	12.38	9.54
Limestone	12	12	7	12	K_2O	4.86	8.06	3.21	5.84
Potassium nitrate	1	1	2	2	CaO	5.02	5.14	2.93	5.13

The crystal glasses require a somewhat high melting temperature and longer time of founding than the opal if the two are to be ready for working out together. To prepare colored base glasses the additions given below can be made to the batches given above, a small amount of boric acid (to be determined by trial) being added to the other glass to be used with the colored glass to balance the change in expansion.

Color	Shade	Suitable for	Addition
Blue	Light aquamarine	Crystal and opal	1 copper sulphate
	Dark blue	" " "	3 copper oxide
	Dark blue	" " "	0.1 cobalt oxide
	Celeste blue	Opal	2.25 copper oxide
Brown	Yellowish-brown	Crystal	3 wood charcoal or 2 graphite
	Golden brown	Crystal and opal	12 "manganese" + 3.5 iron oxide
Yellow	Light amber	Crystal	5.5 "manganese" + 2 iron oxide
	Dark amber	"	7.5 "manganese" + 1.5 iron oxide
	Golden yellow	"	2.5 corn grains
	Straw yellow	Opal	5 antimony sulphide + 1 yellow uranium oxide
Yellowish-green	Yellowish-green	Crystal and opal	3.75 "manganese" + 4.6 iron oxide
Green	Anna green	Crystal	0.625 copper oxide + 0.42 yellow uranium oxide
	Light green	Opal	1.75 potassium chromate
	Dark green	"	1.75 potassium chromate + 2 copper oxide
	Chrysopas green	"	0.4 yellow uranium oxide + 0.35 copper oxide
	Rome green	Crystal	2 potassium chromate + 1.6 copper oxide + 0.6 iron oxide
	Celadon green	Opal	1.25 copper oxide + 0.75 yellow uranium oxide
	Signal green	Crystal	6 potassium chromate + 2.2 copper oxide
Red	Blood red	"	3 stannous oxide + 0.8 cuprous oxide
Black	Hyalith	Crystal and opal	45 "manganese" or 30 basalt + 15 sawdust
Violet	Violet	" " "	3.5 "manganese"

(*J.S.G.T.*)

Opal glasses. II. O. KNAPP. *Glashütte*, **60**, 755 (1930).—The researches of O. Inwald, E. Zschimmer, and K. Fuwa on the effect of phosphate salts in opal glasses are reviewed. The batches in Table I based on 100 sand and in Table II the batch

TABLE I

Bone ash	30	30	28	25	22	18	16	12	10	9	7	6	5	4	4	4
Potash	40	42		8	34	26	32		50	5	28	38	42	33	26	46
Soda ash			50	38	10	10	5	20		40	2					
Red lead	4				22	10		10			3	6				
Zinc oxide	2	2				7										
Lime		30			10	7			13			2		2	4	
Niter				3	3	3	5	3		2	3	2	2	2		3
Baryta				12												
Aluminium hydroxide						1										
Talcum									10	7	2	6	6	7	2	6
Borax							3	13						1	6	

TABLE II

Borax (anhydrous)	32		20		24		20	
Boric acid (crystalline)	6						8	6
China clay							7	6
Sodium nitrate			4		10			
Lithium carbonate								24
Limestone					10			

compositions for devitrification opals are given as typical. Reference is made to other types, including tin-oxide opals. (*J.S.G.T.*)

Absorption and dispersion of light in opal glass. G. M. Drosti. *Kolloidchem. Beihefte*, **33** [1–4], 1–95 (1931).—Since Lord Rayleigh's work on the blue color of the sky in 1871, considerable work has been done on the dispersion of light which shows that it depends on many factors. Experiments were undertaken with solutions of gum mastic of different concentrations. The Rayleigh equation for the change in coefficient of dispersion δ with the wave-length λ, $\delta = \frac{s}{\lambda^4}$, s being constant, is best for fine particles; for layers of coarser particles the equation, $\delta = \frac{s}{\lambda^n}$, where s and n are constants, is found more satisfactory. The value of n was found to decrease with concentrations of mastic per liter of alcoholic solution, reaching 0 at 161 g. per liter. When measuring the permeability of light through a layer of mastic mixed with fuchsin and comparing the results with those calculated, D. found that the pencil of light is weakened independently by absorption and dispersion, though the dye is absorbed by mastic. Formulas are derived for the cases of dispersion and absorption appearing separately and together and for light falling on the dispersing medium in parallel rays and diffused. A formula for approximate determination of the absolute intensity of light passing through a dispersing medium in normal direction is also given. The increase in concentration of mastic results in a decrease of the intensity of light passing through the layer (Beer's law) until a limit is reached where no marked decrease is observed. This limit is made dependent more upon the slit opening of the photometer than upon the light-dispersing particles. Experiments and theoretical considerations show that the relation of the light falling upon the scattering medium and that transmitted through it is greater for coarser than for fine particles. The absorption and scattering coefficients for several kinds of opal glass of various thickness and for lamp-bulb glass were determined by means of the resultant methods. The results are embodied in a number of graphs and 19 tables. A bibliography is also given. J.G.T.

Raw materials for the improvement of glass. F. H. Zschacke. *Glashütte*, **60**, 817 (1930).—Z. points out the desirability of adopting a batch composition that permits the greatest range of ware to be made and one with the most favorable melting and refining properties. Raw materials that might help are feldspar (although bad mixing may lead to cordy glass), borax, and barium carbonate. The last two increase the cost of the batch, although an increase of 8 to 12% is not a very large fraction of the total cost of the finished ware, and might be worth while by reason of the decrease of other losses such as breakages resulting from such additions. Both of these materials improve the appearance of the glass and reduce the time taken for refining. Replacement of lime by barium oxide gives a much less green tint, lowers the coefficient of expansion, and increases the mechanical strength somewhat. With 3 to 5% BaO in place of CaO no cordiness is noticed. (*J.S.G.T.*)

Glass, its composition and properties. Geo. W. Morey. *Jour. Chem. Ed.*, **8**, 421–41 (1931); for abstract see *Ceram. Abs.*, **10** [2], 110 (1931). (*C.A.*)

Physical tests of value to the glassworker. D. E. Sharp and J. Bailey. *Glass Ind.*, **12** [9], 179–83 (1931).—There are a number of simple rapid tests used to distinguish positively between various glasses without resorting to chemical analysis. These tests fall into two groups, (1) comparative behavior of the sample compared with a standard glass, and (2) those which require the determination of some actual physical constant. Descriptions of both types of tests are given. These tests include expansion tests, a test for workability, a rapid test for specific gravity, softness test, and refractive index. Illustrated. E.J.V.

Improving "clinger" glass composition. V. F. Youferov and I. V. Borovikov. *Ceramics & Glass*, **7** [4], 21–22 (1931).—The purpose of the investigations was to produce

a "clinger" glass chemically more durable and to decrease its coefficient of expansion. Twenty-seven new compositions were fused and analyzed. Data on the results obtained are given. M.V.K.

Proper insulation. S. M. JENKINS. *Amer. Glass Rev.*, **50** [48], 13–14 (1931).—Insulation has effected (1) fuel saving, (2) more uniform temperature control, and (3) protection of the workmen. This has brought about other changes such as outer walls made of steel plate or cinder concrete which are both protected by insulating brick. The flues of the glass tank should be insulated with $4^1/_2$-in. insulating brick which will stand water or moisture. Insulated flues increase the draft and help to bring the furnaces up to temperature quickly. Flattening ovens and gas-fired leers have insulating brick back of the fire brick to keep the even, constant temperature required with the least amount of fuel. In electric leers, because of the high cost of electricity, exceptionally heavy insulating brick walls and arches are necessary. The thickness of insulation is graduated according to the temperatures required. The auxiliary equipment should be insulated to carry on the fuel saving throughout the operation. E.P.R.

How many times is glass melted? JAMES BAILEY. *Glass Ind.*, **12** [9], 190–91 (1931).—Each time that glass is melted, alkali is vaporized, clay and other foreign matter is absorbed, color is burned out, ingredients may be oxidized or reduced, and other physical changes take place. The average number of times glass has been melted after a certain number of fills have been made is, for any reasonable percentage of batch, a nearly constant value. The method of calculation is explained in detail and a graph for simplifying the calculations is included. E.J.V.

Investigations by Morey, Kracek, and Bowen in the system, soda–lime–silica. A. DIETZEL. *Sprechsaal*, **64** [31], 573–76 (1931).—The investigations are reviewed and their importance for the glass industry is outlined. Graphs and tables are reproduced. See also *Ceram. Abs.*, **9** [10], 831 (1930); **10** [8], 604 (1931). W.M.C.

Density versus composition of soda-silica glasses. ANON. *Ceram. Ind.*, **17** [3], 192 (1931); for abstract see *Ceram. Abs.*, **9** [10], 831 (1930). W.W.M.

Technical analysis of sodium water glass. E. KRONMANN. *Sprechsaal*, **64** [34], 628–30 (1931).—A simple method of analyzing sodium water glasses and a diagram for water-glass solutions are given. W.M.C.

Influence of cullet on some physical and chemical properties of glass. M. A. BESBORODOV. *Ceramics & Glass*, **7** [4], 11–18 (1931).—B. describes experimental fusions with additions of different quantities of cullet to the batch. The investigations were made on glasses of four compositions for different uses, *viz.*, (1) sodium-lime-silica glass, (2) laboratory glass, (3) thermometrical glass, and (4) glass for electric bulbs. The additions of cullet to the batch were 20, 40, 60, and 80%. One batch of each glass without cullet was fused. Conclusions are as follows: (1) The chemical analyses showed that the quantity of cullet in the batch has no effect on the chemical composition of glass. No dependence was found between the chemical composition of glass and the quantity of cullet added. (2) In some series of glasses a decrease in the coefficient of expansion with an increased quantity of cullet was noticed, but was not confirmed in all cases Samples of glasses taken from the upper layers of the glass tanks at the beginning of the working period had a smaller coefficient of expansion than samples taken at the end of working from the lower layers of the glass tanks. (3) The chemical stability of glasses does not depend on the quantity of cullet in the batch. (4) The quantity of cullet does not influence the velocity of opacification of glasses during working on a blast burner. See also *Ceram. Abs.*, **9** [7], 515 (1930). M.V.K.

Manufacturing glass containing nepheline. G. I. LEVENFISCH. *Ceramics & Glass*, **7** [1], 1–2 (1931).—L. describes the preparation of glass from batches in which soda and sulphate were replaced by nepheline. The analyses of nepheline are given and show

about a 14% alkali content. Glasses composed of SiO_2 58%, Al_2O_3 14%, CaO 14%, and Na_2O 14% were found suitable. Glass containing nepheline showed a greater viscosity than ordinary glass. M.V.K.

Influence of mineralizers on the properties of glass. A. C. GUINSBERG. *Ceramics & Glass*, **7** [4], 18–19 (1931).—G. describes tests with a "Pyrex" glass containing additions of WO_3. The quantity of WO_3 varied between 0.5 and 2% of the weight of the batch. The batch was heated to 1420° for 41 hours and the glass obtained was of good quality. After cooling, the glass containing $1^1/_2$% WO_3 was opalescent and the one containing 2% was milky. An addition of 1% WO_3 was found to be the most suitable. The coefficient of expansion of a Pyrex glass containing 1% WO_3 was found to be $37.5 \cdot 10^{-7} \doteq 1.5 \cdot 10^{-7}$. Investigations showed also that an addition of 1% WO_3 has no influence on the optical properties of the glass. M.V.K.

Data on glasses containing fluorine. A. N. DAUVALTER. *Ceramics & Glass*, **7** [4], 20–21 (1931).—In analyzing milk glasses, D. observed a more or less constant relationship between the fluorine and aluminum contained by the glasses according to the formula AlF_3, although these glasses were different in composition and of different batches. The fact that the greater part of the fluorine contained in the glass remains combined in the form of AlF_4 and that the volatilization of fluorine occurs slowly explains the corrosive action of glasses containing fluorine on fusing tanks because the Al_2O_3 in the grog and "glazing layer" develops into AlF_3. The quantity of fluorine remaining is equivalent to the aluminum content when calculating milk glasses from batches according to fusing tests of opaque nepheline glass. M.V.K.

Physico-chemical properties of glass for electric bulbs. CHERNIAK. *Ceramics & Glass*, **7** [2], 18–25 (1931).—Investigations made to ascertain the physical and chemical properties of glass used for electric bulbs are described. The results are tabulated. M.V.K.

The meaning of "glass for tropical conditions." TEPOHL. *Sprechsaal*, **64** [33], 610–11 (1931).—A main influence on glass in a tropical climate is the humid and warm air. When the glass is shipped to the tropics by way of boats it will be exposed to very humid air for many weeks. Besides this, storage of the glass in the tropics is often done in a primitive way. Consequently the glasses should have a good weathering resistance of about Class III/IV of the German standard specifications. W.M.C.

What is glass? I. Crystallization and devitrification. Edited by GEO. V. MCCAULEY AND C. D. SPENCER. *Ceram. Ind.*, **17** [3], 190–92 (1931).—This article begins a series covering the fundamentals of glass technology, written more particularly for the practical glassworkers, to acquaint them with the chemical and physical reactions which influence the production of good glass. The several processes included in glass-making, rate of crystallization, and devitrification phenomena are related and discussed. Attempts to produce devitrified glass products have met with little success. W.W.M.

Influence of salt and sulphate on window glass crystallization. A. P. SACK AND S. J. JOFE. *Ceramics & Glass*, **7** [4], 23–25 (1931).—Sulphates and chlorides present in a batch do not influence the process of fusing and degasification in a harmful way. On the contrary, they are able to quicken the process. The introduction of chloride into the batch in a quantity exceeding 2% sometimes causes a dimming of the glass. As the glass industry also uses natural soda often possessing impurities in the form of sulphate and chloride, the study of the influence of these impurities on glass crystallization is of the greatest importance. The introduction of NaCl from 0.5 to 5% and Na_2SO_4 from 0.5 to 8% does not influence the speed of crystallization at 800 to 1000°. The introduction of these impurities in the given quantities does not create any phenomenon of opalescence or of increasing crystallization. M.V.K.

Nature of crystals in technical and optical glasses. F. U. BISKE. *Trans. Ukrainian*

Sci. Research Inst. Silicate Ind., Sci. Tech. Dept., Supreme Council Nat. Econ. [U.S.S.R.], Vol. I, 1929.—B. describes methods of inspecting crystals by the ultramicroscope, polariscope, and the polarizing microscope. A table is given of the results of observations on 21 glasses. Several photos of pure SiO_2 crystals and CaO-, BaO-, and PbO-silicate crystals are included. S.I.P.

Causes of crystallization of window glass produced by the Fourcault process. S. U. JUKOVSKY. *Trans. Ukrainian Sci. Research Inst. Silicate Ind.*, Sci. Tech. Dept., Supreme Council Nat. Econ. [U.S.S.R.], Vol. I, 1929.—After a review of the literature on this subject, J. describes his own experiments. Considering the composition of Fourcault glasses, J. refers to the article by Keppeler and Hofmeister (see *Ceram. Abs.*, **7** [11], 750 (1928)) who give the following compositions:

	1	2	3	4
SiO_2	69.73	70.40	68.21	72.50
Al_2O_3	2.13	2.59	2.52	0.90
Fe_2O_3	0.11	0.11	0.12	0.15
CaO	9.98	9.80	11.25	10.58
MgO	0.10	0.09	0.09	0.11
Na_2O	17.34	15.76	16.86	15.21
K_2O	0.77	1.44	1.11	0.46

The composition used most is No. 4 as this glass is more resistant to atmospheric action. In U.S.S.R. compositions similar to No. 4 are used:

	A	B	C
SiO_2	72.0	72.0	73.08
$Al_2O_3 + Fe_2O_3$	0.9	0.9	0.62
CaO	11.3	10.5	9.16
MgO	0.1	0.1	0.10
Na_2O	15.7	16.5	17.04

W. E. S. Turner (see *Ceram. Abs.*, **5** [9], 270 (1926)) recommends a composition for Fourcault glass similar to B: SiO_2 70.64, Al_2O_3 0.77, Fe_2O_3 0.11, CaO 10.58, MgO 0.09, Na_2O 17.02, and SO_3 0.78. Conclusions are as follows: (1) compositions A, B, and C are correct. (2) The temperature of fining or plaining is 1400°C. (3) In case of appearance of seeds, the temperature should be raised to 1420°C. (4) It is desirable to introduce into the glass 1% of magnesium oxide or 1% of alumina in place of alkalis. (5) On introducing free alumina the temperature of fining should be raised to 1440°C. (6) In the case of devitrification the crystals are tridymite and cristobalite. Sometimes a eutectic of the probable composition, tridymite + $Na_2O{\cdot}3CaO{\cdot}6SiO_2$, is observed. In this case the chemical composition of the devitrified mass differs little from the composition of the glass. (7) The crystals of tridymite observed are products of partial metamorphization of undissolved grains of quartz. (8) It was possible to observe the presence of needles covered with cracks which are striae of another composition than the base glass. (9) The temperature of crystallization for the chosen compositions of glass is lower than 980°C and therefore the temperature conditions at the slit of Fourcault's float in the limits of 930 to 950°C may be favorable for crystallization. (10) The crystallization of glass may also depend on the degree of purity of the raw materials. The speed of its appearance is influenced by the volatilization of alkalis from the surface of the glass, the action of furnace gases, the contact of glass with the grog particles of the walls of the tank or pot, and the surface tension of glass. (11) Owing to the unavoidable convection streams on the inside of the tank and channels, in some zones conditions favorable for crystallization may be created. Such places may be detected by thermal investigations of the whole thickness of glass in the tank and channels and by taking samples of glass at different depths. S.I.P.

Cooling of glass in the Fourcault process. G. Nováky. *Sprechsaal*, **64** [24], 452–53 (1931).—The importance of maintaining as even a temperature as possible in the glass-drawing process is emphasized. Different ways to arrange the machines at one glass tank were studied but no quantitative data are given. W.M.C.

Restoration of solarized ultra-violet transmitting glasses by heat treatment. A. Q. Tool and R. Stair. Bur. Stand., *Jour. Research*, **7** [2], 357–74 (1931).—Data show the relation between the ultra-violet transmissions of two commercial glasses (vita- and helio-glass) before and after solarization by ultra-violet radiations at ordinary temperatures and also after various heat treatments in the range 200 to 600°C. The highest ultra-violet transmission was obtained after heat treatments at temperatures in the annealing range, *i.e.*, about 500°C. Treatments at higher temperatures cause deformations and some surface deterioration while those at lower temperatures are less effective in rejuvenating the glass, although treatments at temperatures as low as 300°C often restore the transmissivity approximately to its initial value on receipt of the glass. R.A.H.

Permeability of glasses to ultra-violet radiations. V. P. Gilard, P. Swings, and A. Hautot. *Rev. belge ind. verrières*, **2** [17], 98–102 (1931).—Four series of commercial glasses were made up as follows: (1) boric oxide replaced part of the silica and the effect was favorable in increasing the transparency; (2) three soda-lime glasses and 3 soda-baryta glasses in which the transparencies did not differ greatly; (3) based on 100 SiO_2, 40 Na_2O, and 20 CaO, with varying amounts of As_2O_3 and MnO_2, this series did not show any significant differences in permeability; (4) lead glasses with soda or potash as the alkali, in which the permeabilities were comparable to those in series (3). A glass containing lanthanum oxide was opalescent and did not transmit ultra-violet radiation. Soda glasses containing cerium oxide did not transmit radiation which was shorter than 3300 Å. The same result was obtained with glasses containing potash instead of soda. Didymium and neodymium slightly increased the transparency. The thickness of all glasses influenced the limit of transparency to a marked degree, the thinnest glasses transmitting shorter wave-lengths than the thicker glasses. The wave-length transmitted becomes longer when a glass has been irradiated for fifteen hours. A bibliography is given. For Part IV see *Ceram. Abs.*, **10** [10], 686 (1931). A.J.M.

Manufacture of Vitaglass in the U.S. Anon. *Glass Ind.*, **12** [8], 173–74 (1931).—A new completely automatic process for the manufacture of Vitaglass has been developed by the Flat Glass Specialty Co. at Clarksburg, W. Va., with the assistance of the technical staff of the Vitaglass Corporation and the Chance Bros. & Co., Ltd., of England. This new process is a modification of the Fourcault vertical drawing system and permits drawing large continuous sheets. Glass made by the new process is stated to be slightly stronger than the earlier products. E.J.V.

Investigation on glass permeable to ultra-violet rays. R. Suhrmann and F. Breyer. *Strahlentherapie*, **40**, 789–94 (1931).—The change of the permeability of glass to ultra-violet rays on exposure to the action of the sun and the radiation from the sky as well as to atmospheric conditions is of a photochemical nature. When such glass permeable to ultra-violet rays is stored in dark rooms this change takes place very slowly. This special glass permeable to ultra-violet rays permits all rays of the sun in the region of the infra-red to go through. It absorbs the rays of longer wave-lengths like ordinary window glass. (*C.A.*)

Glass admitting ultra-violet rays. V. V. Vargin. *Ceramics & Glass*, **7** [1], 4–9 (1931).—V. reviews the latest research on glass transparent to ultra-violet rays and describes investigations made by the State Research Ceramic Institute (U.S.S.R.) from which the following conclusions were obtained: (1) The proportion of FeO : Fe_2O_3 present in the glass has a great influence on the transparency of glass to ultra-violet

rays. (2) B_2O_3 and K_2O introduced into the composition of lime-soda glass increase the transparency to ultra-violet rays only when a low content of iron oxide is present in the glass; with an increased iron oxide content, lime-soda glasses show greater transparency than potassium and soda glasses. (3) Transparency of glass to ultra-violet rays depends on fusing conditions which influence the proportion of FeO : Fe_2O_3 in the glass. With a reduced atmosphere in the kiln and with an increase of the fusing temperature, the transparency is increased. (4) The metallic powders of aluminum and especially of magnesium introduced into the batch of the glass were found to be the best reducing agents. M.V.K.

Fused silica in industry. B. MOORE. *Chem. & Ind.*, **50** [32], 671–81(1931).—The subject is considered from the following aspects: (1) choice of raw material, (2) treatment of raw material, (3) molecular structure of fused silica, (4) properties of fused silica, (5) influence of the composition and characteristics of the raw material on the properties of the fused product, (6) methods of evaluating the quality of the raw material and of the fused products, and (7) applications of fused silica in industry. G.R.S.

Strains and annealing of glass and their connection with striae, colorations, stones, and other heterogeneities. F. U. BISKE. *Trans. Ukrainian Sci. Research Inst. Silicate Ind.*, Sci. Tech. Dept., Supreme Council Nat. Econ. [U.S.S.R.], Vol. I, 1929.—Methods of observation of strains in glass and of correct annealing of different kinds of glass are given. The impossibility of annealing a heavily striated glass is pointed out. S.I.P.

Conservation of heat in the annealing of glass. T. C. MOORSHEAD AND E. A. COAD-PRYOR. *Fuel Econ. Rev.*, **10**, 35–38 (1931).—The improvement in annealing furnaces has been from updraft kilns using 90 to 100 therms per ton of glass to tunnel furnaces with endless belts (open and muffle types) using 20 therms per ton to efficiently insulated tunnel furnaces consuming 5.5 therms per ton, rendered possible by the speeding up of the process of glass manufacture, and to furnaces requiring no auxiliary heating. These last are tunnel furnaces heavily insulated at the inlet end and fitted with a conveyer of endless wire mattress. The return part of the conveyer is preheated by the cooling glassware. When operating with light loads heat is supplied by electric heaters. (*B.C.A.*)

Swedish art glass. F. HANSEN. *Glas-&-Keram-Ind.*, **22** [8], 5 (1931).—Venetian glassblowers were the founders of glassmaking in Sweden, the first glasshouse being established in Stockholm under Melchior Jung in 1640. Many Swedish glass products were fashioned on such well-known glasses as those of Baccarat, Lalique, Murano, and Czechoslovakia. The Orrefors glassworks, founded in 1898, has since 1915 established a reputation for the artistic designs evolved by its two artists, Simon Gaté and Edward Hald, each of whom had a distinctive style. Three specialities of the Orrefors Co. are mentioned: (*a*) Graal glasses (cased glasses), (*b*) cut crystal glass, and (*c*) domestic glassware. The latter is made at the company's Sanduk factory and is a soda glass, the Orrefors factory using a potash-lead glass. Details are given of the processes of manufacture, cutting, and engraving. All Orrefors glass is handmade in order to maintain its high artistic qualities. (*J.S.G.T.*)

Standardization of laboratory glassware. ANON. *Glas App.*, **11**, 222 (1930).—It was decided at the November Standards Conference of the Deutsche Gesellschaft für Chemisches Apparatewesen (Dechema) that the glass used in chemical ware must be capable of resisting the action of alkalis, but on the question of the interchangeability

Desiccators and Bell Jars

Internal diameter (mm.)	100	150	200	250
With new rim diameter (mm.)	150	210	270	325
Instead of previous (mm.)	135	180	230	280

of glass stoppers for cylindrical flasks no resolution was reached. The difficulties arising in practice from the restriction in rim diameters for desiccators and bell jars, caused the above limits to be fixed, but, at the same time, the permissible variation was reduced from 10 to 5%. (*J.S.G.T.*)

Difficultly fusible glass for electrotechnical purposes. ANON. *Glashütte*, **60**, 828 (1930).—Glass for lamp electrodes, rectifiers, etc., must withstand high temperatures and be chemically durable. Oxides favoring devitrification have to be excluded as far as possible, and those which are reduced in the flame at the lamp are also valueless. The glass used is a silica, boric oxide, soda glass, a little of the silica being replaced by alumina. A minimum expansion coefficient for a given silica content is obtained when the ratio B_2O_3:Na_2O is about 85:15. (*J.S.G.T.*)

Decolorizing and coloring glass. J. R. HAAS. *Glas App.*, **11**, 163 (1930).—No pure white glass was produced until the 14th Century. Christopher Schürer in Vendeck is credited with the first production of smalt in 1550, using it exclusively himself for a time, and then selling it to the Dutch who used it extensively. The first works in Saxony to handle the product were at Schneebergin in the early 17th Century. Other colored glasses are briefly dealt with and Kunkel's recipe for gold ruby is quoted. (*J.S.G.T.*)

Possible use of glass in the chemical industry. HÖFER AND UEBLER. *Glas App.*, **11**, 211 (1930).—Thermal improvements have been sought through a low expansion glass preferably with as high a heat conductivity as possible, although little variation in this direction is possible, and as a result the more durable Pyrex and similar glasses have been produced. Although with these types of glasses the mechanical properties of the metals have been approached, progress is still necessary in relation to impact and breaking strengths before keen competition with the metals used in the chemical industry can be possible. The complex nature of some of the new special steels necessitates careful heating and cooling conditions and the avoidance of strain, as is necessary in the case of glass. (*J.S.G.T.*)

Researches on bottle glass. K. MÜLLER. *Wochenschr. Brauerei*, **47**, 352 (1930); *Chim & Ind.*, **24**, 1400 (1930).—Certain changes which occur in beer stored in glass bottles has been attributed to the action of the glass. A small amount of alkali is extracted, but the beer is definitely acidic, due to the presence of carbon dioxide as well as organic acids, and the alkali does not neutralize the acidity. The amount of alkali absorbed into the beer is far too small to produce a disagreeable taste. As amber glass of greater solubility preserves the beer perfectly, chemical action is not the cause of the deterioration. The action of light is responsible for the changes, and the clearer and less colored the glass, the more susceptible is the beer to change. Amber glasses are the best for storing the beer unchanged. Light evidently aids in the precipitation of albumen by the tannins. (*J.S.G.T.*)

Bottle glass in U.S.S.R. I. I. KITAIGORODSKY. *Ceramics & Glass*, **7** [3], 10–16 (1931).—Data on the composition and properties of bottle glass manufactured in U.S.S.R. are given. Investigations show that (1) the stability of bottle glass to alkali depends on the quantity of R_2O_3 and SiO_2 present in the glass; (2) stability to water depends on the quantity of R_2O_3, MgO, and R_2O present in the glass; and (3) stability to acids depends on the quantity of R_2O and MgO present in the glass. M.V.K.

Glass as a building material. W. GROPIUS. *Glas App.*, **11**, 213 (1930); for abstract see *Ceram. Abs.*, **10** [8], 557 (1931). (*J.S.G.T.*)

Use of rectified gas in glassworks. SEREBRIAKOV. *Ceramics & Glass*, **7** [4], 9–10 (1931).—S. discusses the advantages of using rectified gas in glassworks basing his conclusions on observations of the operation of two large mechanized window glassworks. The principal advantages of using rectified gas, besides the fact that it is

obtained from low-grade fuel with resin by-products, are (1) the possibility of using the gas through the whole plant by branching, (2) the uniformity of the temperature the whole length of the torch flame in the furnace, (3) the possibility of carbureting gas, (4) the high calorific value of dry gas, and (5) the increase of the pyrometric effect. On the basis of these advantages, S. gives a series of principles for further improvements of Fourcault channel constructions. M.V.K.

Some principles for the construction of tanks. I. I. KITAIGORODSKY. *Ceramics & Glass*, **7** [2], 25–26 (1931).—K. discusses the construction of tanks used for glass manufacturing and points out that the reactions between the glass-forming compounds begin at 500°C, and at 800° they are intense. The viscosity of the mass at 1200 to 1250° permits working, and under certain conditions this temperature is sufficient for its purification. It is useless to maintain temperatures of 1400 to 1480° to remove gases from the batch as this can be done at 1250° by mechanical or chemical means. The process of fusing must be divided into three zones and not two as is done now, *viz.*, (1) the fusing zone in which the reactions proceed in a solid state and in which most of the gases are removed from the batch; (2) the zone of purifying and rendering homogeneous the fusion and during which the remaining gases are removed (the fusion can be made completely homogeneous here by artificial stirring); (3) the zone of working up; the mass enters this zone from the 2nd zone for its working or casting. M.V.K.

Manufacture of rolled plate. XII. ERNST LUTZ. *Glass Ind.*, **12** [9], 184–89 (1931).—Descriptions of the development of the continuous grinding and polishing processes by the Ford Motor Co. and the Pittsburgh Plate Glass Co. are given. Details in which the two processes differ are discussed. Some of the patented features of the continuous processes are enumerated and discussed. Illustrated. For Part XI see *Ceram. Abs.*, **10** [10], 690 (1931). E.J.V.

Tumbler and stemware grinder. ANON. *Amer. Glass Rev.*, **50** [46], 13 (1931).—A. B. Knight has developed an 8-spindle tumbler and stemware grinding machine. The machine has large capacity at small labor cost and is completely self-contained. E.P.R.

Mechanizing the window glass production in U.S.S.R. I. F. SOLOVYEV. *Ceramics & Glass*, **7** [4], 4–6 (1931).—The building and reconstruction of glassworks performed last year for the purpose of the mechanization of this branch of industry was accomplished after many difficulties and mistakes, particularly in the production of window glass. The choice of machinery (system Fourcault) is correct but the building of factories progresses slowly. The preliminary estimations are overdrawn considerably: the cost of production, although lower than that of handwork still remains high, the quality of the glass is not satisfactory, and the manufacturing per cent of thin glass is low. The reasons for this lie in insufficient planning, exorbitant prices of buildings, and wrong organization of separate phases of the technical processes. M.V.K.

Injuries and diseases of the mouth and teeth of glassblowers and their treatment and prevention. W. HERRMANN. *Zentr. Gewerbehyg. Unfallverhütung*, **17**, 193–97, 218–23 (1930).—A thorough article which treats of the diseases due to the blowpipe and diseases such as syphilis and other communicable diseases. The diseases resulting from the irritation of the blowpipe on the lips and teeth are given thorough study. The Fe_2O_3 is adsorbed by the tartar on the teeth. HF acts on the teeth and bacterial infection occurs in the lesions. (*C.A.*)

History of drinking glasses. ARMAND BAAR. *Rev. belge ind. verrières*, **2**, 102–105 (1931).—Illustrated. See also *Ceram. Abs.*, **10** [10], 691 (1931). A.J.M.

Glassmaking in medieval Italy. F. URBANI DE GHELTOF. *Ind. Silicati*, **9** [7], 11–12 (1931).—The art of making mirrors and window panes progressed rapidly in Venice and Murano at the end of the 16th and the beginning of the 17th Centuries.

The mirrors produced were in demand in all the countries of Europe. The Italian artisans were finally induced in 1665 by the minister, Colbert, of France, and in 1670 by the Duke of Buckingham in England to bring the secrets of their art to these countries. See also *Ceram. Abs.*, **10** [8], 540 (1931). M.V.K.

Rare pieces of ancient glass shown at Toledo Museum of Art. ANON. *Amer. Glass Rev.*, **50** [47], 14 (1931).—Syrian glass vessels of the first century, blown in a mold, are adorned with protuberances to facilitate holding them, and are probably forerunners of German prunted glass of the 15th and 16th Centuries. A group of blown glassware dating from the 1st to the 4th Centuries A.D. includes a variety of bottles, bowls, and jars, iridescent as the result of age and decomposition of the surface. The blowpipe for making glass, attributed to the Syrians, was used about the 3rd Century B.C. The group of Jewish glassware of the 4th Century A.D. is credited to be the largest and finest in the world. E.P.R.

Amalgamation in Belgian industry. WALTER H. SHOLES. *Commerce Repts.*, No. 36, p. 610 (1931).—The large plate-glass manufacturers in Belgium recently amalgamated to meet foreign competition as exports for the first five months of 1931 show a decrease of over 25% as compared with the same period in 1930 and 50% with 1929. See also *Ceram. Abs.*, **10** [1], 78 (1931). E.J.V.

Manufacture of glass in Manchuria. ERIC T. KING. *Commerce Repts.*, No. 32, p. 344 (1931).—Manufacture of glass in Manchuria was first undertaken at Dairen in 1914. With a capitalization of $150,000 the 1930 output was valued at $350,000 but the 1931 will be down 50%. American automatic blowing and pressing machines are used, all other machinery being Japanese. The firm manufactures all kinds of cut, blown, and pressed glassware, ranging from low-priced goods to high-grade cut glass products. Illustrated. E.J.V.

Production decline in Polish glass industry. HARRY L. FRANKLIN. *Commerce Repts.*, No. 36, p. 610 (1931).—The output in 1930 dropped to 77,100 metric T. compared with 109,000 metric T. in 1929. Exports in 1930 totaled 1759 metric T. worth 1,853,600 zlotys, compared with 1707 T. in 1929, worth 1,664,000 zlotys. Imports in 1930 amounted to 7855 metric T. worth 11,507,500 zlotys, compared with 10,767 metric T. worth 14,856,000 zlotys in 1929. E.J.V.

BOOK

White Glasses, Hollow Glassware, and Laboratory Glassware. (Les verres blancs, les verres creux et les verres de laboratoires.) FRIEDRICH SPÄTE. Vol. 7. Published by Akademische Verlagsgesellschaft, Leipzig. 192 pp., 38 plates. Price, 14.8 Rm. Reviewed in *Rev. belge ind. verrières*, **2** [17], 111 (1931).—This is Vol. 7 of the series of 10 volumes edited by Gehlhoff and Quasebart. Some of the chapter headings are as follows: lead crystal, Bohemian crystal, table glassware, glass food containers, pressed glass, etched and cut glassware, glass tubing and laboratory glassware, bottles, illuminating glassware, colored glasses, opals, plated ware, medical glassware, hardened glass, and special glasses which are transparent or opaque to certain radiations. An index is given. A.J.M.

PATENTS

System for grinding and polishing glass sheets. JOHN L. DRAKE. U. S. 1,819,017, Aug. 18, 1931. In a system of the character described, a pair of substantially parallel tracks, tables movable along the tracks, transfer means between the tracks at one end, means for moving one of the tables from one track onto the transfer means, and separate means for simultaneously moving a second table from the transfer means onto the second track.

Treatment of cast glass sheets and plates. YVON BRANCART. U. S. 1,819,221,

Aug. 18, 1931. In a process of producing glass plates and sheets, casting molten glass on a flat surface, subjecting the fluid glass to the action of an impressing roller adapted to form therein temporary impressions running longitudinally of its direction of travel, driving the roller at a higher circumferential speed than if it were simply rolling on the table to simultaneously form temporary impressions extending at an angle to the first-named impressions, and allowing the impressions to be evened up while the glass cools.

Device for adjusting the thickness of glass plates and sheets. YVON BRANCART. U. S. 1,819,222, Aug. 18, 1931. In combination with a casting table, a calibrating roller, a pair of bearings for the roller, a pair of carriage bodies each carrying one of the bearings, wheels supporting the carriage bodies, the wheels resting on the table, screws interposed between the wheels and the carriage bodies, the screws engaging the bodies, and means for locking the carriage bodies in adjusted position with respect to the screws.

Glass rolling train. YVON BRANCART. U. S. 1,819,223, Aug. 18, 1931. In a rolling train for the manufacture of glass plates and sheets, a rocking frame comprising a pair of side members, a pair of arc-shaped shoes supporting the side members, two pairs of rolls journaled in the side members, and an arc-shaped base supporting the shoes.

Table for casting glass sheets and plates. YVON BRANCART. U. S. 1,819,224, Aug. 18, 1931. A table for casting glass sheets and plates comprising a metal plate for receiving the glass, the plate having ribs on its underside and grooves between the ribs, a chamber under the plate, a bottom plate closing the chamber, two recesses each located in one of the grooves at opposite ends of the chamber, two water pipes each opening into one of the recesses at a level above the bottom of the grooves, and a steam outlet tube of small cross-section leading from the top of the central portion of the chamber.

Making composite glass. NICHOLAS J. PENNING. U. S. 1,819,336, Aug. 18, 1931. A process of making a composite glass plate, which consists in assembling alternating sheets of glass and tough reinforcing material having their opposing surfaces prepared so as to become attached together upon the application of heat and pressure, applying protecting means to the edges of the assembled sheets, and submerging such sheets in a bath of hot mercury under pressure.

Drawing glass sheets or plates. ARTHUR E. SPINASSE. U. S. 1,819,392, Aug. 18, 1931. In the art of drawing sheet glass from a body of molten glass, the step that consists in intermittently engaging the edge portion of a drawn wedge of plastic glass above the body of molten glass by a squeezing tool, and imparting downward movement to the squeezing tool while the latter is engaged with the edge of the glass wedge.

Glass feeder. THOMAS STENHOUSE. U. S. 1,819,446, Aug. 18, 1931. A glass feeder including a flow spout having a flow orifice, a plunger reciprocable in the flow spout in vertical alignment with the flow orifice, and means for reciprocating the plunger, the plunger having an airtight connection with the flow spout.

Treating cast glass sheets and plates. ARTHUR BRANCART. U. S. 1,819,670, Aug. 18, 1931. In combination with a table for receiving cast glass plates and sheets, a movable hollow rod having a flat underside resting on the table and a perforated convex upper side, the rod being mounted at one end on a pivot at right angles to the plate, a gas supply pipe connected to the pivoted end of the rod, and means for swinging the rod about the pivot.

Glass-shaping machine. EDWARD H. LORENZ. U. S. 1,819,903, Aug. 18, 1931. A glassware-forming machine comprising a rotatable turret, an annular series of radially disposed bearings carried by the turret, a drum in each of the bearings, a mold carried

by each drum, each drum being provided with a seat, spring-thrown plungers carried by the turret and movable therewith, respectively, for engaging each seat, and a movable cam independent of and beneath the turret and effective at a predetermined place in the turret rotation for successively withdrawing each plunger from its seat and retaining it in an inoperative position during the inversion of the drum and the mold, the cam being effective successively to withdraw the plungers from their seats irrespective of whether the turret be moving or stationary.

Receiving table for cast glass. CLAUDE LOCREILLE. U. S. 1,819,959, Aug. 18, 1931. A table for casting and receiving glass plates and sheets, the table comprising a slab made of a concrete formed of a ground mixture of calcined lime, silica, and alumina, with fragments of porphyry embedded therein, the slab comprising a bottom layer having fragments of porphyry 20 to 30 mm. in size, intermediate layers with fragments, respectively, 10 to 20 mm. and 5 to 10 mm. in size, and a top layer containing pulverized porphyry, metal armatures embedded in each except the top layer, the armatures comprising transverse and longitudinal bars, circles, and wire netting, and a metal band encircling the slab.

Making glass. JOHAN KRISTOFFER BJÖRN RAEDER. U. S. 1,820,247, Aug. 25, 1931. In apparatus of the class described, the combination with an electric furnace for melting glass or other similar fusible material in which the molten material contained therein acts as a resistance for the electric current, of spaced electrodes disposed within the furnace and positioned therein so as to be totally submerged in the bath, the electrodes extending through the furnace wall, and being enlarged within the furnace in a direction at right angles to the direction of passage of current, the electrodes being fluted, whereby the contact surface is sufficiently great to prevent melting or corrosion of the electrodes. See also *Ceram. Abs.*, **10** [9], 639 (1931).

Glassmaking furnace. JOHAN KRISTOFFER BJÖRN RAEDER. U. S. 1,820,248, Aug. 25, 1931. An electric resistance glassmaking furnace in which molten glass serves as a resistance to the flow of an electric current, comprising a chamber adapted for the reception of a bath of molten glass, the chamber having an inlet above the level of the bath through which glassmaking materials may be fed to the bath and having an outlet at a lower level submerged by the molten glass, and spaced electrodes totally submerged by the molten glass in the chamber and disposed above the level of the outlet. See preceding patent.

Annealing glassware. THOMAS WARDLEY. U. S. 1,820,260, Aug. 25, 1931. Apparatus for annealing glassware comprising a leer, heating flues extending longitudinally through the leer, a fire box, a burner for directing a flame of combustion into the fire box, passageways leading from the fire box to the flues, a deflector positioned in the fire box against which the flame impinges, the deflector having diverging surfaces, and an air inlet port in the fire box located between the deflector and the burner.

Glass-feeding apparatus. JULIUS SYLVESTER. U. S. 1,820,508, Aug. 25, 1931. In glass-shaping machinery and in combination with gob-delivering apparatus which includes a feeder needle, means for reciprocating the feeder needle, the means including a lever reciprocating on a movable fulcrum, means for moving the fulcrum longitudinally of the lever, the means including a vertically arranged hydraulic cylinder containing a piston with extended stem, a hydraulic relay associated with the cylinder, the relay including a vertically reciprocable member, a lever pivoted to the stem of the piston of the hydraulic cylinder, the vertically reciprocable member of the relay being connected to the lever, a lever linked to the last-named lever and adapted to swing on a fixed pivot, and means subject to the weight of a descending gob of glass for causing the lever so pivoted on a fixed support to swing through a greater or less range, according to variation in the weight of succeeding gobs.

Glass-edging machine. JOSEPH CAPELLMAN. U. S. 1,820,778, Aug. 25, 1931. In an edging machine, an endless carrier including a plurality of flexibly connected blocks having transversely disposed grooves in one face, means to movably mount the carrier, edging elements mounted upon the other face of the blocks, a backing plate, a rib disposed longitudinally of the backing plate for engagement within the grooves of the blocks to guide them and hold the edging elements in properly aligned relation, and means to movably support and guide the work in contact with the edging elements.

Glassdrawing machine. HOWARD ZEH. U. S. 1,820,930, Sept. 1, 1931. A flag for Fourcault sheet-glass drawing machines, comprising a body portion having flaps pivoted thereto and arranged to deflect particles of glass away from the sheet, supporting means secured to the flag, the supporting means being rotatably mounted whereby upon rotation of the means the flag is rotated to dispose it for introducing a bait between the drawing rolls.

Glassware-forming machine. HAROLD A. ROHRICH. U. S. 1,821,077, Sept. 1, 1931. In a glassware-forming machine, the combination of a mold carriage, a dipping frame mounted for vertical sliding movement on the carriage, means to move the dipping frame downward relative to the mold carriage at regular time intervals, a guide member mounted at the upper end of the mold carriage, a connector rod carried by the dipping frame and extending upwardly through the guide member, a coil spring encircling the rod above the guide member, and means for confining the spring between the guide member and the upper end of the rod.

Treating glass. YVON BRANCART. U. S. 1,821,375, Sept. 1, 1931. A process of treating rolled sheet or plate glass consisting of coating the underside of a perforated surface with a combustible material, feeding glass at glowing temperature over the surface, causing the material to be ignited by the glowing glass, and causing the ignited gases given off by the material to flow through the perforations in the surface, thus producing between the surface and the glass a gaseous cushion by the combustion of the material.

Laminated glass. GEORGE B. WATKINS. U. S. 1,821,598, Sept. 1, 1931. As a new article of manufacture, a sheet of laminated glass consisting of two or more sheets of glass with an interposed nonbrittle material treated with an amide having a relatively high boiling point and low vapor pressure, the vapor pressure being sufficiently low that the sheet will not bubble when subjected to varying climatic conditions encountered in actual use.

Forming and annealing sheet glass. CARROLL CONE. U. S. 1,821,617, Sept. 1, 1931. In a sheet-glass apparatus, a conveyer for receiving a newly formed sheet thereupon, including two sets of rolls arranged in the same horizontal plane and adapted to simultaneously engage the sheet and carry it forwardly, the rolls of one set being arranged alternately with the rolls of the other set, and means for positively driving the sets of rolls in the same direction at different speeds.

Sheet glass. JOSEPH P. CROWLEY. U. S. 1,821,618, Sept. 1, 1931. In sheet glass apparatus, a conveyer for receiving a newly formed sheet from a sheet-forming mechanism at one speed and delivering it to an annealing zone at a relatively slower speed, including two sets of rolls arranged in the same horizontal plane and adapted to simultaneously engage the sheet and carry it forwardly, means for positively driving the sets of rolls in the same direction at different speeds, and means for disconnnecting the drive from one set of rolls to cause the rolls to run idle.

Spinning glass filaments. PAUL O. E. FRIEDRICH. U. S. 1,821,937, Sept. 8, 1931. In a glass-spinning machine, the combination with a mechanism comprising a pair of spaced upright headers, a plurality of glass rods supported by one of the headers, means on the other header for rotating the rods at substantially the same speed, means

on one of the headers and movable therewith for uniformly heating the rods, and a spinning wheel for drawing glass threads from each of the rods, the wheel being covered on its cylindrical face with a fabric whereby the glass threads may be caused to adhere thereto.

Production of continuous glass strips. ERNEST BRISTOW LE MARE. U. S. 1,822,627, Sept. 8, 1931. In a glass-strip rolling apparatus, means for feeding the plastic strip over a flat stationary bed onto a roller bed at the start of the rolling operation, comprising two bars pivotally attached each at one end to the side of the bed and free to be turned upward about their pivots, the bars being each provided with a series of notches adapted to act as fulcrums with which a lever bar can be successively engaged while one end of the lever bar is engaged with the plastic glass of the strip.

Sheet-glass producing apparatus. LEOPOLD MAMBOURG. U. S. 1,822,704, Sept. 8, 1931. In sheet-glass apparatus, a tank furnace containing a mass of molten glass, a relatively shallow draw pot connected to and in open communication with the furnace for receiving the molten glass therefrom, means for drawing a sheet vertically from the glass in the draw pot including a horizontally traveling draw table, a rotatable member for deflecting the sheet through an angle of approximately 90° from the vertical into the horizontal plane, hood means arranged over and adapted to cover the molten glass in the draw pot, a closed compartment carried by the hood means and having a vertical portion and a horizontal portion extending at substantially right angles with respect to the vertical portion for enclosing the vertical and horizontal portions, respectively, of the sheet being drawn, the horizontal portion of the compartment tapering toward its exit end and terminating in advance of but closely adjacent to the draw table, the horizontal portion of the compartment having a movable part for varying the size of the exit end of the compartment, and a depending baffle wall carried by the hood means and dipping downwardly into the mass of molten glass at substantially the juncture of the furnace and draw pot.

Introducing batch ingredients into glassmelting furnaces. NESTOR MAMBOURG. U. S. 1,822,705, Sept. 8, 1931. The combination with a glassmelting furnace having an opening in its rear vertical wall extending substantially the entire width thereof and a plurality of spaced vertical buckstays engaging the vertical wall to assist in tying the furnace structure together, of a plurality of inclined plate members carried by the buckstays and arranged between the same and projecting slightly into the furnace through the opening, the members being adapted to receive the batch and feed it into the furnace throughout substantially the entire width thereof, an adjustable gate associated with each opening and through which the members also project, a hopper associated with each member for initially receiving the batch and delivering it thereto, and a rotatable batch feed control member within each hopper.

Sheet-glass rolling apparatus. JOHN L. DRAKE. U. S. 1,822,959, Sept. 15, 1931. An apparatus for producing sheet glass, embodying a receptacle containing a mass of molten glass and a pair of superposed rotatable members arranged above the receptacle at one end thereof, the members being positioned in advance of the mass of molten glass with the lower portion of the periphery of the bottom member being arranged at substantially the level thereof, the rotatable members being adapted to draw a body of glass upwardly from the adjacent end of the receptacle and to reduce the body of glass to a sheet of substantially predetermined thickness.

Glass-feeding machine. CLAUDE W. PLEUKHARP AND HARRY RAYNES. U. S. 1,823,062, Sept. 15, 1931. (1) In a glass-feeding machine, the combination with a charging vessel having a discharge orifice for molten glass, a plurality of delivering devices for delivering measured quantities of molten glass to different stations and comprising each a swinging chute, and means to control the swinging chutes to vary the

time of movement of one with relation to the other. (2) The method of producing mold charges of different sizes for making glassware, which comprises discharging molten glass from a container, and severing the discharged glass at regulated unequal intervals of time, adapted to the different sizes to be produced.

Two-table glass forming machine. KARL E. PEILER. U. S. 1,823,123, Sept. 15, 1931. In combination with a bath of molten glass, a continuously rotating two-table glass fabricating machine, a blow mold mounted on one table, a parison mold and neck ring mounted on the other table, means for moving the parison mold about a vertical pivot fixed on the parison-mold table to a projected position, means for dipping the parison mold while in such position into the glass bath, means for gathering a charge from the bath by suction into the parison mold, means for severing the charge so gathered, means for forming a parison in the parison mold, and means for transferring the parison so formed to the blow mold.

Making sheet glass. ROBERT L. FRINK. U. S. 1,823,357, Sept. 15, 1931. The method of making sheet glass which comprises substantially continuously forming a glass sheet, causing the same to travel in an unsupported horizontally-extending path whereby the glass droops in such travel, and thereafter causing flexing of the glass in a direction opposite to the direction in which it is flexed during such drooping.

Sealing laminated glass. FRANK H. BELL. U. S. 1,823,525, Sept. 15, 1931. An apparatus for filling with sealing material the sealing slot at the edge of laminated glass which comprises a pot for the sealing material, a roller support for the glass at one side of the pot, a rotating disk arranged to dip into the sealing material and having a thin edge to enter the sealing slot, the sealing disk having shoulders at the sides of the thin edge to support the glass at the level of the roller support, and means to rotate the disk independently of the movement of the glass.

Drawing glass in cylindrical form. GEORGE E. HOWARD. U. S. 1,823,543, Sept. 15, 1931. The method of drawing glass tubing continuously, that comprises flowing a stream of molten glass upon the inner surface of a hollow receiver, rotating the receiver around a stationary implement contained therein, withdrawing the glass between the implement and the wall of an outlet at one end of the receiver, and forming the withdrawn glass into tubing.

Glassware-transfer device. GEORGE E. ROWE. U. S. 1,823,574, Sept. 15, 1931. A glassware-transfer device adapted to receive noncircular articles of glassware in one position and turn the articles of glassware around a vertical axis to a predetermined position while transferring them from one location to another, comprising a conveyer, a frame therefor, plates pivotally mounted thereon, arms on the plates, glassware-receiving cups mounted on the plates, an abutment member located to contact with the arms and to turn the plates to one position for receiving the articles of glass, and a second abutment member located to contact with the arms and turn the articles of glassware to another position for delivering them.

Annealing. HARRY M. ROBERTSON. U. S. 1,823,629, Sept. 15, 1931. The process of annealing which consists in supplying heat to a charged chamber and simultaneously exhausting the products of combustion from the lower portions of the chamber at a plurality of points by forced draft, to raise the temperature of the chamber to the desired degree and conducting the products to and discharging them into the upper portion of the chamber to produce a nonoxidizing atmosphere therein, then in reducing the heat supply to the chamber and rate of exhaust therefrom to produce suitable soaking conditions in the chamber, and then slowly cooling the chamber.

Glass mirrors, reflectors, etc. GLAS-FABRIKEN UND RAFFINERIEN JOSEF INWALD A.-G. Austrian 122,753, Dec. 15, 1930. The Ag backing is protected with Ni deposited thereon by electrolysis. (*C.A.*)

Delivering batches of molten glass, etc. VEREINIGTE GLÜHLAMPEN- UND ELECTRICITÄTS A.-G. Austrian 123,080, Jan. 15, 1931. (*C.A.*)

Automatic cut-off device for glass-drawing machines. INDUSTRIE- UND MONTANGES M.B.H. Austrian 123,099, Jan. 15, 1931. (*C.A.*)

Drawing glass tubes. R. HADDAN. Brit. 354,509, Aug. 19, 1931.

Giving colored glasses a reddish tinge. DEUTSCHE GASGLÜHLICHT AUER-GES. Brit. 354,566, Aug. 19, 1931.

Manufacture of glass yarn. O. GOSSLER. Brit. 354,763, Aug. 26, 1931; see also *Ceram. Abs.*, **9** [10], 838 (1930).

Treating frosted-glass articles. R. HADDAN. Brit. 354,909, Aug. 26, 1931.

Machines for making electric lamp bulbs, etc. BRITISH THOMSON-HOUSTON CO., LTD. Brit. 355,220, Sept. 2, 1931.

Temperature regulators. BRITISH HARTFORD-FAIRMONT SYNDICATE, LTD. Brit. 355,467, Sept. 2, 1931.

Feeding elongated flexible articles, *e.g.*, glass tubes, and canes. R. HADDAN. Brit. 355,477, Sept. 2, 1931.

Treating edges of laminated glass. B. L. GREGG. Brit. 355,541, Sept. 2, 1931.

Forehearths for glassmelting furnaces. L. MELLERSH-JACKSON. Brit. 355,555, Sept. 2, 1931.

Delivering or transferring bottles from bottle-forming machines. ALBION BOTTLE CO., LTD., AND A. D. R. TUCKER. Brit. 355,588, Sept. 2. 1931.

Glass-feeding apparatus. UNITED GLASS BOTTLE MFRS., LTD., AND E. P. DORMAN. Brit. 355,590, Sept. 2, 1931.

Devices for drawing glass tubes or rods. GENERAL ELECTRIC CO., LTD. Brit. 355,599, Sept. 2, 1931.

Manufacture of laminated materials. NEWTEX SAFETY GLASS CO., LTD., AND W. C. DOUGAN. Brit. 355,604, Sept. 2, 1931.

Tunnels for annealing glass. SOC. ANON. DES MANUFACTURES DES GLACES ET PRODUITS CHIMIQUES DE ST.-GOBAIN, CHAUNY, ET CIREY. Fr. 702,550, Aug. 21, 1930. (*C.A.*)

Electric furnace for melting glass. JOHAN K. B. RAEDER AND SOCIÉTÉ RAEDERS ELEKTROGLASOVN A/S. Fr. 702,850, Dec. 27, 1929. (*C.A.*)

Glass. I. G. FARBENIND. A.-G. Fr. 703,671, Oct. 14, 1930. Glass containing TiO_2 is made by melting a charge in which the necessary alkali is at least partially in the state of nitrate, at a temperature below 1350° and in the presence of a clarifying or decolorizing agent. An example of a charge contains K_2CO_3 47.1, KNO_3 17.2, $CaCO_3$ 42.8, SiO_2 100, TiO_2 71.5, and As_2O_3 0.3 parts. The glass obtained has an n of 1.7. Other examples are given. (*C.A.*)

Rotary furnace for melting glass. L. BOSSE. Ger. 507,837, May 8, 1928. A horizontal cylindrical rotary furnace is fed with batch and fuel, *e.g.*, gaseous, liquid, or pulverulent, at one end through apertures roughly situated on the axis of rotation, while the molten glass is removed through a similar axial aperture at the other end. (*J.S.G.T.*)

Fire finishing bottle necks. HALLESCHE PFANNERSCHAFT ABTEILUNG D. MANSFELD A.-G. F. BERGBAU AND HÜTTENBETRIEB. Ger. 507,838, Sept. 12, 1929. In a machine for fire finishing bottle necks in which the cups carrying the bottles are mounted on a rotating table, gripping members are provided to each cup to support the bottle neck below the mouth and so prevent distortion. (*J.S.G.T.*)

Protecting the glass sheet in the Fourcault process. T. WEINBERG. Ger. 508,016, Oct. 21, 1928. The protecting device consists of thin arms or plates fitting tightly to-

gether, disposed mainly near the thickened edge of the glass sheet so that they trail on the latter. (*J.S.G.T.*)

Emptying casting pots. M. BICHEROUX. Ger. 508,115, July 4, 1929. The pot is placed by means of a crane between two circular segments capable of rotation on guide rollers, the pouring position of the lip coinciding with the axis of rotation. The whole is supported in a suitable framework. (*J.S.G.T.*)

Polishing glass plates. HERZOGENRATHER GLASWERKE BICHEROUX ET CIE, G.M.B.H. Ger. 508,455, Nov. 8, 1929. In polishing glass plates by means of felt pads affixed to tools the tools are circular in shape and are arranged to overlap the work-table in their motion by an amount at least equal to the width of the tool, so that the whole of the pad in this position is rubbed on the edge of the plate and automatically cleans itself. (*J.S.G.T.*)

Blowing bottles. L. VERHAERT. Ger. 508,598, March 14, 1926. In blowing bottles in which the parison is blown in the inverted blank mold and then blown up in a finishing mold, one neck mold serving the two operations, the parison is transferred to the finishing mold still in the inverted position and blown up. (*J.S.G.T.*)

Rack-driven grinding machines. SOC. ANON DES ATELIERS HEUZE MALEVEZ ET SIMON RÉUNIS. Ger. 510,289, Oct. 31, 1928. In a device for grinding glass plates where several work tables are driven by a toothed rack engaging gear wheels on the tables, means are provided for maintaining the height of the tables as they move down the rack. (*J.S.G.T.*)

Registering of neck molds with blowing heads. J. WALKER & SONS, LTD. Ger. 510,502, Sept. 14, 1927. Pins in the blowing head engage in suitable recesses in the neck mold so that when the two halves of the latter are closed they are pressed against the blow head. (*J.S.G.T.*)

Continuous production of sheet glass. A. SCHILD. Ger. 510,503, June 28, 1927. The glass is fed from an aperture in the side of the tank to a space furnished by two rolls with suitably disposed end-retaining pieces, the level of the glass being the same as that in the furnace. Practically complete uniformity of temperature is obtained by adjustment of the position of the upper roll and a suitably disposed cooling duct playing on the upper surface of the glass. (*J.S.G.T.*)

Sealing up cracks in glass rings. J. RIEDEL. Ger. 510,505, Aug. 4, 1928. The broken rings are set between supporting fingers in a revolving holder and the slightly projecting end is warmed by tangentially disposed burners, the crack being held closed by the inward pressure of the fingers. (*J.S.G.T.*)

Feeding molten glass. DEUTSCHER VERBAND DER FLASCHENFABRIKEN G.M.B.H. Ger. 510,944, June 23, 1926. Means are provided for surrounding the plunger by a circular housing connected to cooling ducts. See also *Ceram. Abs.*, **10** [8], 565 (1931). (*J.S.G.T.*)

Production of Fresnel lenses. GEUTHE & CO. Ger. 511,406, Feb. 5, 1927. The lenses are cast centrifugally by dropping a charge of molten glass into suitably shaped rotating molds. (*J.S.G.T.*)

Grinding-cleaning working surfaces. SOC. ANON. DES ATELIERS HEUZE MALEVEZ ET SIMON RÉUNIS. Ger. 511,858, Feb. 8, 1929. One or more scraper blades are fixed above the work surface to swing with their wiping edge in contact with the work. (*J.S.G.T.*)

Holding glass articles while grinding. T. A. BEHR AND M. LANGER. Ger. 511,859, July 17, 1928. In order to counteract the tendency to tilt glass vessels, *e.g.*, basins and vases, while being ground on the base, means are provided for applying an adjustable load on the upper rim of the vessel at a point opposite that at which the leading edge of the tool meets the work. (*J.S.G.T.*)

Assembling small electric lamps. M. KARKUTSCH. Ger. 512,051, Sept. 24, 1929. The device consists of a plate provided with a hole to take the body of the lamp and allow it to protrude a few millimeters on the upper side for the purpose of receiving the flame from the burner for fusing in the leads, the plate being suitably distanced from a base plate on which the device rotates. (*J.S.G.T.*)

Special transmission electric lamp bulbs. F. SKAUPY. Ger. 512,153, July 21, 1928. Electric lamp bulbs are made of heat-resisting glass as transparent as possible in the visible range of the spectrum and as opaque as possible in the infra-red. (*J.S.G.T.*)

Glass feeding device. DEUTSCHER VERBAND DER FLASCHENFABRIKEN G.M.B.H. Ger. 512,167, March 2, 1923. The outflow of glass through the bottom of a feeder boot is controlled by a sleeve and reciprocating plunger located at a suitable distance above the orifice. (*J.S.G.T.*)

Arrangement of leads in projection lamps. N. V. PHILIPS' GLOELAMPENFABRIEKEN. Ger. 512,418, Nov. 13, 1927. Projection or special illuminating lamps, having long leads in a narrow cylindrical glass body, have the body considerably enlarged near the cap, and the inner leads to the filament are taken close together as near the axis of the narrow tube as possible. (*J.S.G.T.*)

Composition of glass for alkali vapor lamps. PATENT-TREUHAND-GES. FÜR ELEKTRISCHE GLÜHLAMPEN M.B.H. Ger. 513,306, Aug. 30, 1929. Illuminating tubes filled with alkali metal vapor (in particular with that of sodium), are made of a borosilicate glass which, in addition to considerable boric oxide with alkali, alkali earth, and aluminium oxides, contains less than 50% silica. (*J.S.G.T.*)

Improved debiteuse for drawing sheet glass by the Fourcault process. N. KRASNIKOV. Ger. 513,379, Feb. 2, 1927. While the inner surfaces forming the slit of the debiteuse are cooled by a suitable fluid flowing through, the outer faces are protected by insulating material from the cooling action so that they do not affect the glass entering the slit. (*J.S.G.T.*)

Drawing quartz tube and cane. A. E. G. Ger. 513,380, April 2, 1927. In drawing quartz tube or cane, the temperature of the furnace and therefore the degree of melting of the quartz is so regulated that a constant velocity produces a uniform size of product. (*J.S.G.T.*)

Production of mold charges. HARTFORD-EMPIRE CO. Ger. 513,479, Dec. 3, 1925. Glass flowing from an outlet in a suitable container is blown out by compressed air while hanging from the outlet and is then cut off. (*J.S.G.T.*)

Decorated hollow glassware. W. HIRSCH. Ger. 513,509, Nov. 24, 1927. The pattern is ground on the inner enameled surface of the glass. (*J.S.G.T.*)

Intermittent rolling of glass sheets. SOC. ANON DES MANUFACTURES DES GLACES ET PRODUITS CHIMIQUES DE ST.-GOBAIN, CHAUNY, & CIREY. Ger. 513,767, Dec. 7, 1928. In rolling sheet glass in which the fluid glass is poured from a ladle or pot onto a table, where it flows between the sizing rolls, the table is provided with an upturned front edge which forms a weir that retains the glass until the whole width of the table is full of the latter before it overflows to the rolls. (*J.S.G.T.*)

Device for drawing molten glass from the furnace. DEUTSCHE VERBAND DER FLASCHENFABRIKEN G.M.B.H. Ger. 524,973, July 16, 1924; see also *Ceram. Abs.*, **10** [8], 565 (1931). (*C.A.*)

Heating glass-annealing furnaces. ARTHUR BRANCART. Ger. 525,120, Sept. 21, 1926. The heating gas is prepared by dropping water onto glowing coke, and is passed countercurrent to the glass without any purification. (*C.A.*)

Method of making tile, etc., by heating powdered glass, etc., under pressure. RENIER JONKERGOUW AND JACQUES DEMONGEOT. Ger. 525,440, Nov. 11, 1928. (*C.A.*)

Glass. RUDOLF VON KREYBIG AND ZOLTÁN VON VERESS. Ger. 525,441, Nov. 8, 1927. An acid glass resembling porcelain is prepared by fusing a mixture of SiO_2, 62 to 70%, with alkaline earths, 38 to 30%. The initial materials may be quartz sand and dolomite. Coloring additions, etc., may be included in the mixture but alkalis must not be present. Examples are given. (*C.A.*)

Drawing filaments of glass and like thermoplastic materials. ÉMILE CHAUDOUARD, GEORGES LAVIER, AND MICHEL PORTERET. Ger. 526,046, Oct. 13, 1929. (*C.A.*)

Rolling plate glass. THEODOR MELZ. Ger. 527,185, Jan. 28, 1930. (*C.A.*)

Glass. FELIX SINGER. Ger. 528,175, April 25, 1929. The tensile strength of glass having a high content of Al_2O_3 is raised by including up to about 1% of a sulphide in the melt. The sulphide may be added as such or formed *in situ*. Details of the use of CaS and FeS are given. (*C.A.*)

Reheating piece glass to the softening point. FRIEDRICH RICHTER. Ger. 528,176, March 11, 1930. (*C.A.*)

Withdrawing molten glass from a container. DEUTSCHER VERBAND DER FLASCHENFABRIKEN G.M.B.H. Ger. 528,476, April 16, 1920; see also *Ceram. Abs.*, **10** [8], 565 (1931). (*C.A.*)

Structural Clay Products

Degassing clays before molding. H. R. STRAIGHT AND M. G. COWMAN. *Jour. Amer. Ceram. Soc.*, **14** [10], 701–705 (1931).

Missouri hard flint clay fire brick. M. E. HOLMES AND A. J. PAUL. *Jour. Amer. Ceram. Soc.*, **14** [10], 755–63 (1931).

Researches in dry-press refractories. III. Effect of vacuum on unfired properties of some dry-press refractory batches. W. C. RUECKEL. *Jour. Amer. Ceram. Soc.*, **14** [10], 764–69 (1931); for Part I see R. E. BIRCH, *Ceram. Abs.*, **9** [5], 353 (1930); for Part II, *ibid.*, **9** [12], 1054 (1930); see also *ibid.*, **10** [5], 358 (1931).

Latest progress in dry-press research. W. C. RUECKEL. *Brick Clay Rec.*, **79** [5], 202 (1931).—Following the work with gases in the mold during pressing, the latest development in overcoming pressure cracks consists of an adaptation of an old process dating back 30 years or more. This consists of applying to the clay in the mold a pressure sufficient to develop pressure cracks, releasing the pressure to allow the escape of entrapped air, and re-pressing at a sufficiently high pressure to heal the pressure cracks or laminations previously formed. E.J.V.

Properties of some North Dakota bentonites. FREIDA L. HAMMERS AND W. E. BUDGE. *Jour. Amer. Ceram. Soc.*, **14** [10], 742–46 (1931).

Reports of committee on reinforced brick masonry. NATIONAL BRICK MANUFACTURERS RESEARCH FOUNDATION. *Clay-Worker*, **96** [2], 82–90 (1931); *Brick Clay Rec.*, **79** [5], 216–18 (1931).—Report No. 1 describes a demonstration structure of reinforced brick masonry and gives detailed instructions for its building. Only 800 brick and the necessary mortar and steel bars are required. The design of the demonstration structure is typical of standard building construction. Report No. 2 covers descriptions and results of load tests to destruction of the slabs of three demonstration structures at Philadelphia, Montreal, and St. Louis. These reports are given in full. Illustrated. E.J.V.

Effects of transverse loads upon reinforced brick masonry. E. F. GALLAGHER. *Brick Clay Rec.*, **79** [3], 110–14 (1931).—Considerable data on tests made on reinforced brick beams, in which only two variables, those of length and section, were used, are presented both in tables and in graphic form. Methods of making the various determinations are explained and some of the calculations are illustrated. E.J.V.

Test of twenty-foot reinforced brick beam. JUDSON VOGDES. *Clay-Worker*, **96**

[2], 96–97 (1931).—Data are presented on a test of a 20-foot beam of reinforced brick which was $8^1/_4$ in. wide and $25^1/_2$ in. deep, reinforced with $5^3/_8$-in. deformed bars placed so that their center of gravity occurred in the line of the bottom joint. It was found that the safe working load of this particular beam was 525 lb./ft. of beam or 10,500 lb. uniformly distributed. Illustrated. E.J.V.

Reinforced brick masonry in plant construction. JUDSON VOGDES. *Clay-Worker*, **96** [2], 98–100 (1931); *Brick Clay Rec.*, **79** [5], 220–22 (1931).—A detailed description and discussion of a reinforced brick masonry conveyer support which replaced a wooden structure and at the same time instituted some modifications in the conveyer design at the Price Brick Co. plant at Chester, Pa., is presented. Illustrated. E.J.V.

Reinforced brick masonry in resident construction. ANON. *Clay-Worker*, **96** [2], 97–98 (1931).—The possibilities of this new type of masonry feature for residential construction have been demonstrated in the erection of a house in Moorestown, N. J., as reinforced masonry of brick is used over almost all openings. Illustrated. E.J.V.

Practical application of reinforced brick masonry. HUGO FILIPPI. *Clay-Worker*, **96** [2], 92–95 (1931).—A detailed description is given of the designing and construction of reinforced brick sand storage bins for the Wedron Silica Co., consisting of one circular bin with an inside diameter of 25 ft. 1 in., divided into two compartments by a cross-wall, and a second bin with an inside diameter of 16 ft. $2^1/_2$ in., both bins being 52 ft. high. Problems involved and their relation to the future of the brick industry are discussed. Illustrated. E.J.V.

Brick mortar bond shear tests. EDWARD E. KRAUSS. *Clay-Worker*, **96** [2], 106–107 (1931); *Brick Clay Rec.*, **79** [5], 218–20 (1931).—A brief report is given of some brick mortar bond shear tests made at the Superior Press Brick Co., St. Louis, Mo., to record the method used. No conclusions are drawn from the results. Illustrated. E.J.V.

Effect of scum on the color of face brick. H. B. HENDERSON. *Clay-Worker*, **96** [2], 104–105 (1931).—The influence of scum in the development of a pleasing color effect on fired clayware is discussed. It is proposed that many of the unusual colors such as tans, saffrons, and some of the greens are due to scum coating fired in and combined with the clay surface of the ware. Illustrated. E.J.V.

Manufacture and merchandizing of sand-lime brick. WILLIAM P. COLEMAN. *Rock Prod.*, **34** [17], 48–50 (1931).—Operations of the Grande Brick Co., Grand Rapids, Mich., are described. A table of absorption, flexure, and crushing tests is given. Absorption of the brick varies from 11.0 to 13.3%, modulus of rupture varies from 442 to 654 lb. per sq. in., and the crushing load varies from 3040 to 4050 lb. per sq. in. Molding, steam curing, and testing of the brick are described. The city of Grand Rapids specifies sand-lime brick almost exclusively for construction above and below ground, and many local corporation and private enterprises are using it for building. W.W.M.

Sand-lime brick industry. ANON *Can. Eng.*, **61** [5], 69 (1931).—A brief summary is given of the output of the eleven plants manufacturing sand-lime brick in Canada in 1930. G.R.S.

Washing process in brick plants. O. EGGERT. *Tonind.-Ztg.*, **55** [64], 925 (1931).—Some remarks as to ancient and modern forms of washing processes are described. W.M.C.

Laminations of brick formed in the extrusion machine. J. SCHWARZ. *Tonind.-Ztg.*, **55** [63], 912–13 (1931).—Means of reducing laminations in the brick are described, emphasizing a long mouth of the press, roughening of the body inside the press, and means of driving out the air during pressing. W.M.C.

Varieties of flat-slab construction. G. P. MANNING. *Engineering*, **131** [3412], 722–24; [3413], 754–55 (1931). A.A.

Need of standard specifications for brick. ANON. *Brit. Clayworker*, **40** [471], 126–27 (1931).—The necessity of having a recognized standard test for porosity and strength of common brick is discussed. Several methods of testing these properties are briefly described. R.A.H.

Pressure tests of brick. H. KOSTRON. *Tonind.-Ztg.*, **55** [61], 888 (1931).—Pressure tests of different brick have shown that in most cases the smallest values are obtained at the front side and the largest at the long side of the brick. The values are smaller for larger cubes than for smaller ones. W.M.C.

Brick drying in open-air sheds. ANON. *Tonind.-Ztg.*, **55** [61], 889–90 (1931).—The reason for brick drying poorly in open-air sheds often lies in the false handling of the plant and not in the construction. W.M.C.

Heating behavior of dry-pressed brick. W. F. C. NEIMANN. *Tonind.-Ztg.*, **55** [62], 900–901; [63], 915–16 (1931).—A dry-pressed brick originally containing only 5 to 8% moisture will gain considerable strength only at temperatures above 1050°C when the fluxes contained in it will soften. The coarser the material or clay used, the higher is the pressure required for forming the brick. Some data are given showing the influence of pressure on the qualities of the fired brick. Some other questions are discussed in connection with the heating behavior of dry-pressed brick such as motion of the brick inside the furnace during sintering, influence of furnace size, etc. W.M.C.

Effect of freezing on a plastered building. ANON. *Tonind.-Ztg.*, **55** [60], 877 (1931).—A house is shown in which plaster and brick were attacked by freezing after keeping the soil around the house very wet in summer. W.M.C.

Tests in brick plants. ANON. *Can. Eng.*, **61** [7], 61 (1931).—A brief discussion is given of the experimental work being undertaken in brick plants of Quebec and the Maritime Provinces for the production of gray and buff-colored brick, which at present are imported. G.R.S.

Choosing paving brick. ANON. *Brick Clay Rec.*, **79** [3], 126–27 (1931).—A test road section is made up of $3^1/_2$-in. paving blocks set on a cement sand bed. Another section consists of $2^1/_2$- by $2^1/_2$- by $1^7/_8$-in. brick cubes laid in steel-grating forms with cement mortar. Enameled brick are used for traffic lane markers. Illustrated. E.J.V.

Brick road. F. WATTEBLED AND F. CARINI. *Rev. mat. constr. trav. pub.*, No. 261, pp. 116–18*B* (1931).—The development in the U.S. of tests for paving brick is described giving specific tests and their authors. See also *Ceram. Abs.*, **10** [10], 702 (1931). M.Y.H.

Road surfacing in the U.S. ANON. *Engineering*, **132** [3417], 59 (1931). A.A.

Manufacture of paving brick in U.S. and Holland. G. A. HODSON. *Trans. Ceram. Soc.* [Eng.], **30** [2], 37–45 (1931). C.G.H.

Structural Clay Tile Association plans promotion of light-weight unit. ANON. *Brick Clay Rec.*, **79** [3], 106–107 (1931).—Effort toward commercializing the light-weight, cellular clay products is to be made through the organization of a holding company to promote this new material. Only members of the Structural Clay Tile Assn. will be permitted to subscribe to stock in the company. E.J.V.

Hollow-clay units with closed ends. ANON. *Brick Clay Rec.*, **79** [4], 159 (1931).—Hollow brick can be made in any size desired with the hollows closed at one or both ends by means of quickly rotated cylinders, the circular ends of which are specially cup-shaped with the outer edge sharpened. The machine equipped for the process consists of three principal parts: (1) for cutting off hollow units, (2) the transfer automatically of cut-off brick to closing mechanism, and (3) the closing operation. Illustrated. E.J.V.

Manufacture of hollow brick. C. GALLAUS. *Tonind.-Ztg.*, **55** [66], 947–48

(1931).—The possibilities of developing different types of hollow brick by making brick closed from all sides and brick of large size are described. W.M.C.

Perforated brick. ANON. *Brit. Clayworker*, **40** [471], 137 (1931).—The perforated brick known as the "Dubrick" is described. R.A.H.

Technical supervision of brick plants. P. THOMAS. *Tonind.-Ztg.*, **55** [67], 957–58; [68], 973; [69], 986 (1931).—The importance of control in brick plants is pointed out, emphasizing the use of modern apparatus at the plant and control of raw materials by a well-equipped laboratory. Special care should be taken in connection with an efficient operation of the kilns and the generation of power. W.M.C.

New clay building unit. JOS. WADE. *Brick Clay Rec.*, **79** [4], 174 (1931).—Calgary Clay Products' new patented building units possess unusual features. The "universal dovetail tile" (or nailing block) and the "multiple insulating reinforceable central circulating air-space building units 1 and 2" are described and illustrated. E.J.V.

Growth of building field. ANON. *Brick Clay Rec.*, **79** [3], 121–24 (1931).—The increased possibilities in the application of the various new materials developed in the clay industry are pointed out and specific instances are cited. Illustrated. E.J.V.

Clay tile house is fireproof. WM. E. WILSON. *Brick Clay Rec.*, **79** [5], 204–206 (1931).—W. has constructed in Hyde Park, Cincinnati, Ohio, a home using hollow clay products from the footings up which has withstood the fire tests specified by the fire department and containing structural tile floors which sustained the load test prescribed by the building department. Both the fire officials and the building department gave the dwelling a rating of 100%. A detailed description of the construction of the dwelling. the load tests made, and the actual fire test conducted on July 19, 1931 is given. Illustrated. E.J.V.

Brick for interiors. FINZER BROTHERS CLAY CO. *Brick Clay Rec.*, **79** [5], 230 (1931).—A "marble cake" building brick, designed for interior work, made of shales and clays which give a mottled marble effect, is being announced. E.J.V.

Home building costs. CLARENCE K. BROS. *Brick Clay Rec.*, **79** [4], 160–62 (1931).—An original and a revised cost schedule and specification for the construction of a home are given. It is shown how the masonry wall can be retained and savings made on other portions of the house without reducing the quality thereof. Illustrated. E.J.V.

Design home building. HENRY DUBIN. *Brick Clay Rec.*, **79** [4], 163–67 (1931).—A common brick house, modern in design, is described. Illustrated. E.J.V.

Brick flower basket. ANON. *Brick Clay Rec.*, **79** [3], 128 (1931).—A brick basket $4^1/_2$ ft. wide, $9^1/_2$ ft. high, and 3 ft. deep, built of 1800 brick in 7 colors and varieties by R. C. Gangwere as a memorial piece is described. Illustrated. E.J.V.

Flowerpot production by brick plants. ANON. *Tonind.-Ztg.*, **55** [61], 892–93 (1931).—It is pointed out that the production of flowerpots may be sometimes of good profit for brick plants. W.M.C.

Silica brick plant in Ohio. ANON. *Wellston* (Ohio) *Sentinel; Rock Prod.*, **34** [17], 37 (1931).—The Ohio Quartz Corp. is constructing a brick plant at Jackson for the production of fire brick from silica gravel. W.W.M.

Swedish brick plant, Lina. ANON. *Tonind.-Ztg.*, **55** [69], 987–88 (1931).—This plant, which is operated only during the summer time is described. Common and porous brick are being manufactured. W.M.C.

BULLETIN

Manufacture of Gray Brick, Using Ontario Clays. LITTLE AND R. J. MONTGOMERY. Issued by Ontario Department of Mines. *Can. Chem. Met.*, **15** [8], 50 (1931). E.J.V.

PATENTS

Brick setter. WILLIAM W. WALLACE. U. S. 1,820,332, Aug. 25, 1931. In a brick setter, a finger frame including a pair of uprights having parallel arms, brick clamp operating mechanism, a pair of levers connected to the mechanism and to the arms, a second pair of levers connected to the uprights and pivoted intermediate their ends to the first pair of levers, a turntable, and links connecting the levers and turntable.

Mechanical brick press. GASTON RIGAUX. U. S. 1,820,366, Aug. 25, 1931. A device for cutting or breaking down clay for use in brick presses, comprising a drive shaft, feed hoppers for receiving the clay, a rigid frame carrying transverse cutters arranged one above the other, means actuated by the drive shaft for moving the frame laterally toward the clay wall and then downwardly in a vertical direction, and means for conveying the clay into the feed hoppers.

Brick and pallet centering device. GRAFTON E. LUCE AND THOMAS B. HUESTIS. U. S. 1,820,471, Aug. 25, 1931. The combination with a conveyer for movably supporting a pallet having brick thereon, of means for simultaneously aligning the pallet relative to the conveyer and the brick relative to the pallet including a slidably-mounted crosshead member having a portion adapted to engage the brick and a portion adapted to engage the pallet, and power means for reciprocating the member.

Brick mold. J. ADDISON CROWELL. U. S. 1,822,646, Sept. 8, 1931. A brick mold comprising sides, bottom panels, partitions, and end blocks, a metallic plate affixed to the top of each end block, and a panel under each end block, the inner sides of the metallic plate, the end block, and the end-block panel constituting a continuous flush wall spaced from the adjacent end partition and adjacent bottom panel.

Building wall. LUTHER S. MUNSON. U. S. 1,822,820, Sept. 8, 1931. In a wall construction formed of interfitting tile elements having complementally formed end portions of substantially V-shaped protrusions and recesses, the apex of each protrusion having a channel therein, a column of mortar positioned in each of the channels and impinging against the adjacent tile element, the remainder of the complementally formed end portions being spaced.

Hollow brick. D. H. LEE. Brit. 354,438, Aug. 19, 1931.

Refractories

Use of small quick-acting kilns for instruction and research. F. H. NORTON. *Jour. Amer. Ceram. Soc.*, **14** [10], 725-28 (1931).

Grog. C. R. F. THRELFALL. *Trans. Ceram. Soc.* [Eng.], **30** [1], 1–20 (1931).—T. discusses fundamentally the use of a high percentage of grog in fire brick from both the manufacturers' and the users' point of view. The bond should be prepared by blunging. A known and exact quantity of the bond slip and well-soaked grog should then be blunged until every particle of grog is coated with a film of the bond slip. Thorough mixing of the entire body is necessary. Aging and repugging is advocated. See also *Ceram. Abs.*, **10** [2], 122; [3], 199 (1931). C.G.H.

Works tests on refractories and service conditions. R. J. SARJANT. *Trans. Ceram. Soc.* [Eng.], **30** [2], 46–67 (1931); for abstract see *Ceram. Abs.*, **10** [1], 39 (1931). C.G.H.

Examination of refractory products. VI and VII. MARCEL LÉPINGLE. *Rev. mat. constr. trav. pub.*, No. 260, pp. 87–89*B* (1931); for abstract see *Ceram. Abs.*, **10** [10], 706 (1931). **VIII.** *Rev. mat. constr. trav. pub.*, No. 261, pp. 105–107*B* (1931).—Methods are given for testing the resistance of refractories to chemical agents and to fluxes. The "Dortmund Union" is recommended for determining which tests are

absolute, which give relative or partial results, and which are only qualitative. For Part V see *Ceram. Abs.*, **10** [10], 706 (1931). M.Y.H.

Expansion of silica brick. B. LONG. Communication to Congrès Technique de l'industrie Cèramique, May 27, 1930; for abstract see *Ceram. Abs.*, **10** [4], 275 (1931). (*J.S.G.T.*)

Permeability of refractory materials to gases. A. KANZ. *Chim. & Ind.*, **24,** 1131 (1930); for abstract see *Ceram. Abs.*, **10** [9], 643 (1931). (*J.S.G.T.*)

The P.C.E. of coarse-grained refractories. W. D. KELLER. *Ceram. Age*, **18** [1], 18–19 (1931).—K. tested the fusibility of test cones made from coarse-grained fire brick and cones from the same material after reducing the grain size to conform to A.S.T.M. specifications. The results of tests on three samples showed a variation in P.C.E. values. The data presented indicate (1) that there is a nonuniform variation between the fusibility of coarse-grained refractories containing constituents differing chemically or mineralogically in both plastic and nonplastic components and their pulverized equivalents, and (2) that there is a nonuniform variation between the fusion of the coarse-grained materials mentioned and their standard P.C.E. R.G.M.

Refractories in the carbonizing industries. T. F. E. RHEAD AND R. E. JEFFERSON. *Chem. & Ind.*, **50** [27], 564–68 (1931).—The importance of the correct dimensions, surfaces, and angles is not sufficiently realized. Thermal expansion of refractories results in movement of the pieces so that joints tend to open. With poorly made materials, permanent volume changes may cause even more trouble than that due to thermal expansion. Importance of jointing cements cannot be overemphasized. Good jointing material will have chemical and physical characteristics similar to the refractories with which it is in contact. Good refractories frequently fail because of bad design of the plant. Attempts are being made to prevent leakage by the use of interlocking brick. The production of special refractories for each zone is being investigated. In addition to conscientious bricklayers, ample supervision is necessary. One of the greatest difficulties is the raising of the temperature uniformly throughout the mass, and a strict control of heats must be kept. G.R.S.

Refractories for the induction furnace. J. H. CHESTERS AND W. J. REES. *Engineering*, **131** [3413], 775–76; [3415], 844–45 (1931); see also *Ceram. Abs.*, **10** [10], 707 (1931). A.A.

Refractories in relation to open-hearth furnaces. R. T. LINTERN. *Fuel Sci. Practice*, **10** [7], 337–38 (1931); for abstract see *Ceram. Abs.*, **10** [6], 435 (1931). R.G.M.

Factors influencing durability of refractories in heating and melting furnaces. W. J. REES. *Fuel Sci. Practice*, **10** [7], 332–33 (1931); for abstract see *Ceram. Abs.*, **10** [6], 436 (1931). R.G.M.

Refractories for heating and melting furnaces. ANON. *Fuel Sci. Practice*, **10** [7], 331–38 (1931); *Proc. Sheffield Soc. Eng. & Met.* (1931). R.G.M.

Refractories for heating furnaces from the consumer's point of view. R. J. SARJANT. *Fuel Sci. Practice*, **10** [7], 336–37 (1931); for abstract see *Ceram. Abs.*, **10** [6], 435 (1931). R.G.M.

Refractories from the furnace builder's point of view. H. SOUTHERN. *Fuel Sci. Practice*, **10** [7], 333–36 (1931); for abstract see *Ceram. Abs.*, **10** [6], 434 (1931). R.G.M.

German standard specifications for refractory materials. ANON. *Tonind.-Ztg.*, **55** [64], 923–25 (1931).—New proposals for standardization of furnace linings and coke-oven brick are given. W.M.C.

Furnace walls. II. GEORGE P. REINTJES. *Blast Fur. Steel Plant*, **19** [9], 1270–72 1931).—A description of the refractory clay deposits in the North Central Missouri

field and in the Cheltenham district is given. Manufacturing methods are discussed as are ways to alter the physical characteristics of the brick. Installation has a great influence on a brick service success. For Part I see *Ceram. Abs.*, **10** [8], 574 (1931). E.J.V.

Special refractories for use at high temperature. WM. H. SWANGER AND FRANK R. CALDWELL. *Brick Clay Rec.*, **79** [4], 170–72 (1931); for abstract see *Ceram. Abs.*, **10** [10], 704 (1931). E.J.V.

Cheapening the making of fire brick, nozzles, and stoppers. P. P. BUDNIKOFF, S. A. SHICHAREVICH, AND I. G. SHACHNOVICH. *Brit. Clayworker*, **40** [471], 151 (1931).—To produce first-class nozzles and stoppers more cheaply than is otherwise practical Budnikoff, Shicharevich, and Shachnovich have devised a process of manufacture, the chief feature of which is that no grog is used. The ground fire clay is passed through a 75-mesh sieve. The coarser particles (0.012 to 0.020 in. diameter) are heated for 3 hours at 350 to 400 °C to reduce their plasticity. After screening, particles 0.02 to 0.20 inch in diameter are used; 85 to 95% of the heated material and 15 to 5% of raw fire clay are mixed dry and then a 0.6% solution of silicate of soda is added. For brick, pressures of 1150 to 3500 lb./sq. in. are used for shaping. After drying for 2 days at 30 to 35 °C they are fired at 1300 °C, this temperature being reached in 7 hr. For nozzles and stoppers, similar materials are used, but the heated particles are 0.02 to 0.06 in. in diameter and the raw clay 0.02 in. The water-glass solution contains 0.75% sodium metasilicate and the mix about 10 to 20% water. See also *Ceram. Abs.*, **10** [3], 194 (1931). R.A.H.

Insulating materials for high temperatures. ANON.: *Tonind.-Ztg.*, **55** [67], 960–16 (1931).—Insulating properties of different materials are discussed and figures for thermal conductivities at 538 °C and 871 °C are given. W.M.C.

Insulating fire brick. BABCOCK & WILCOX CO. *Blast Fur. Steel Plant*, **19** [9], 1254–55 (1931); *Chem. Met. Eng.*, **38**, 480 (1931); see also *Ceram. Abs.*, **10** [10], 706 (1931).

Requirements for fire brick in the power industry. E. L. LINDSETH. *Brick Clay Rec.*, **79** [5], 202–203 (1931).—Progress in the power plant industry has outstripped progress in the refractory industry and the power plants have been forced to resort to sectionally supported walls and to replace refractories to a considerable extent by wholly or partially water-cooled or in some cases air-cooled metal walls. The common ways in which fire brick fails in such furnaces are (1) slag penetration, (2) spalling due to thermal shock, (3) spalling due to mechanical strains, and (4) the brick face breaking away when the slag is loosened by means of a slice bar. L. gives nine requirements of a fire brick for power plants. A discussion follows. E.J.V.

Abrasives and bauxite. M. V. CHARRIN. *Rev. mat. constr. trav. pub.*, No. 261, pp. 236–38 (1931); for abstract see *Ceram. Abs.*, **10** [2], 87 (1931). M.Y.H.

Résumé of a course in glassmaking. XII. ANON. *Rev. belge ind. verrières*, **2**, 106–108 (1931).—The discussion of refractories is continued with corrosion, cast refractories, sillimanite, and cast mullite being treated. For Part XI see *Ceram. Abs.*, **10** [10], 690 (1931). A.J.M.

New unit. A. P. GREEN FIRE BRICK CO. *Brick Clay Rec.*, **79** [4], 156 (1931).—In the new stiff-mud department equipped with four tunnel kilns, an approximate monthly production of 4,000,000 brick will be possible. The equipment of the plant is described. E.J.V.

PATENTS

Clay gun clamping mechanism. KING H. MCLAURIN. U. S. 1,822,630, Sept. 8, 1931. Clamping mechanism for clay guns, comprising movable clamping arms movable to and from a position of engagement with the gun, a prime mover for the arms, and

means interposed between the prime mover and the arms for transmitting pressure thereto indirectly while under no load and direct pressure thereto when the clamping load is applied, the load pressure being applied at substantially right angles to the no-load pressure.

Forming graphite molds or other refractory articles. HAROLD E. WHITE, JOHN HESS, AND OSCAR E. NEUHAUSEN. U. S. 1,823,180, Sept. 15, 1931. (1) The method of making a hollow refractory article which consists in placing an unconsolidated plastic mixture in a container, simultaneously jarring and flowing the mixture in the container while pressure is applied to the upper surface of the mixture characterized in that the mixture is caused to flow upwardly within the container by a gravity-operated piercing tool and that pressure is applied to the upper surface of the flowing mixture exterior of the piercing tool by a gravity-operated member, and that the material is subjected to substantially the same pressure during the piercing action by the piercing tool and the member. (2) In apparatus for forming hollow refractory articles, a forming mold into which the article-forming material is deposited, means for positioning the forming mold on a jarring table, a hollow cylindrical gravity operable plunger movable within the mold to pierce and compress the contained material, valve means carried at the lower end of the hollow plunger, and a gravity operable follower associated with the plunger and disposed within the forming mold.

Refractory article. ROBERT L. FRINK. U. S. 1,823,356, Sept. 15, 1931. As a new article of manufacture, a body of material adapted to withstand high furnace temperatures, the body having a face portion which is dense and continuous in character and having an integral body extending continuously behind the dense face portion, the body being porous, and the porosity of the body increasing toward the face thereof opposite the dense face portion.

Electric furnaces. CARBORUNDUM CO., LTD. Brit. 354,172, Aug. 19, 1931.

Terra Cotta

Observations on crazing in terra cotta glazes. C. W. PLANJE. *Jour. Amer. Ceram. Soc.*, **14** [10], 747–50 (1931).

Overglaze polychrome cone No. 6. A. M. STRUSHOLM. *Jour. Amer. Ceram. Soc.*, **14** [10], 751–54 (1931).

Chemical stoneware. FELIX SINGER. *Ceram. Age*, **17** [6], 300–305 (1931); *Brit. Clayworker*, **40** [472], 192–95 (1931).—S. describes a special chemical stoneware body with which, if the heating process is not permitted to progress to the point where spinels begin to form, it will be found possible to decrease the coefficient of expansion of the finished stoneware product to 0.10×10^{-6}. This figure is less than one-fifth of the figure for silica glass. This stoneware body has the smallest coefficient of expansion of any of the ceramic bodies known today. The following comparison shows the development in stoneware quality:

PHYSICAL CHARACTERISTICS OF CHEMICAL STONEWARE

	Year		
	1905	1921	1931
Ultimate strength tension (lb./sq. in.)	710	1,650	7,500
" " compression (lb./sq. in.)	21,200	82,800	116,800
" " bending (lb./sq. in.)		5,900	13,950
" " torsion (lb./sq. in.)		3,750	4,580
Modulus of elasticity (lb./sq. in.)		5.95×10^{-6}	5.95×10^{-6}
Coefficient of thermal expansion per 1°F		2.3×10^{-6}	0.083×10^{-6}
Thermal conductivity (B.t.u./sq. ft./hr./1°F difference in temperature through 1 ft. thick)		0.9	2.64

COMPARATIVE TESTS OF CHEMICAL STONEWARE

	Year 1921	1931
Hardness (ball pressure test similar to Brinell)	1044	1253
Resistance to fracture (swinging hammer)	1.9	4.7
Abrasion (loss of weight under sandblast)	3.0	1.8
Toughness (loss of weight in ball mill)	3.6	2.6

R.G.M.

Causes of cracks in the manufacture of plastic machine-made roofing tile. J. BENTLY, JR. *Trans. Ceram. Soc.* [Eng.], **30** [5], 187 (1931).—This particular type of crack is caused by (1) improper mixing resulting in nonuniform moisture content, (2) incorrect die design, (3) improperly scoured pressing tile bat, (4) horsing a tile when too hard, (5) too rapid drying, (6) too rapid watersmoking, (7) improper camber to the setter, (8) stacking dry tile on green ones in setting a kiln, and (9) failure to dust sand on the setter. C.G.H.

Devon redware pottery. ANON. *Pottery Gaz.*, **56** [651], 1276–80 (1931).—The history of the Litchdon Pottery, which dates back to 1704, and the development of the artistic redware to its present high standard are traced and the clay pit and ware are described. Illustrated. E.J.V.

Production of flowerpots. ANON. *Brick Clay Rec.*, **79** [4], 175–76 (1931).—The Pfaltzgraff Pottery Co., York, Pa., equipped with modern equipment, including a tunnel kiln and a 5-tunnel drier, and using rational production methods, has a possible annual output of 12,000,000 flowerpots of different sizes, but of uniform quality. A general description of the plant and methods used is given. Illustrated. E.J.V.

Architectural stoneware pottery. ANON. *Tonind.-Ztg.*, **55** [69], 987 (1931).—Some experiments as to the best composition of glaze and body are described. W.M.C.

Modern brick building and architectural pottery. F. HOEGER. *Tonind.-Ztg.*, **55** [60], 869–72 (1931).—Modern trends in architecture are outlined which prefer brick as building materials. W.M.C.

Engobed brick of various colors. E. NIEBLING. *Tonind.-Ztg.*, **55** [68], 970–72 (1931).—Colored brick open large possibilities for architectural purposes. Engobing of the brick, firing, raw materials, and testing are discussed. W.M.C.

Ceramic coating of walls. ANON. *Tonind.-Ztg.*, **55** [66], 944–45 (1931).—Different means of coating the walls of homes which were shown at the building exposition at Berlin are discussed. W.M.C.

Metallized terra cotta. M. BARRETT. *Brit. Clayworker*, **40** [470], 120–21 (1931).—Metals are being used to an increasing extent for the decoration of buildings, but such metals lack structural properties unless used at an uneconomical thickness. The process involved in the metal spraying of terra cotta is discussed in detail as well as the pistol which is used for this purpose. The metallization process as applied to terra cotta is still in the development stage and it is too early yet to hazard any opinion as to its ultimate commercial possibilities. R.A.H.

Blue brick. ANON. *Brit. Clayworker*, **40** [472], 3 pp. inserted between pp. 182 and 183 (1931).—The marl clay from which the brick are made needs drastic treatment to form the necessary plastic mass. The clay contains 6 to 8% iron oxide. The brick are finished at about 1200°C in a reducing atmosphere. When the reducing action has proceeded sufficiently, the brick are salt glazed. These brick are used mainly in the construction of bridges, sewers, platforms, and railway storage sheds. R.A.H.

Colorful clay products. ANON. *Brick Clay Rec.*, **79** [4], 168–69 (1931).—A description of the Union Trust Building in Detroit, Mich., in which brick, terra cotta, and wall tile in twelve colors were used for exteriors and interiors, is given and photographs display some of the effects obtained. E.J.V.

Color in brick buildings. W. D. RICHARDSON. *Clay-Worker*, **96** [2], 105 (1931).—An interesting development in architecture in the past 30 years has been the wider use of color in brick and terra cotta. The change in demands of fashion in brick over the thirty-year period is traced and discussed. The newer developments in colored glazed brick, etc., are commented upon. E.J.V.

Use of oversize brick in modern skyscrapers. ANON. *Ceram. Age*, **18** [1], 21 (1931).—The use of a brick unit one and one-half times the length of standard brick and two courses high is described. Illustrated. R.G.M.

Glazed clay and the builder. ANON. *Ceram. Age*, **18** [1], 29–36 (1931). R.G.M.

A Paris architect's office. M. ROUX-SPITZ. *L'Architecte*, pp. 47–49 (June, 1931).—This architect's office comprises a draftsman's room with specially designed furniture and lighting fixtures, reception room and vestibules fitted to display architectural plans and projects, and a private office of polished glass, smooth shelves, wide horizontal windows, hidden radiators, etc. Illustrated. (*D.I.*)

Glazing and coloring machines. PAASCHE AIRBRUSH CO. *Nat. Glass Budget*, **47** [18], 12 (1931).—The above company has announced an automatic machine for glazing, tinting, and coloring brick and clay products. See also *Ceram. Abs.*, **10** [10], 716 (1931). E.P.R.

Intelligent selling of clay products for interiors. ANON. *Brick Clay Rec.*, **79** [3], 125 (1931).—A knowledge of the correct use of interior materials with reference to color treatment and reflective properties of the products is helpful to salesmen. A discussion gives helpful information. E.J.V.

BOOKS AND BOOKLET

New Style Architecture and Decorative Design. ANON. Batsford, London, 1931. $7.50. The title of this book in its original French, L'Art Moderne Primtif, conveys the theme. The subtitle "A Survey of Its First Phase in Europe and America" expands it. The introduction emphasizes the functional beauty of contemporary architecture and decoration. Illustrated. (*D.I.*)

Wind Stresses in Buildings, with a Chapter on Earthquakes and Earthquake Resistance. R. FLEMING. John Wiley & Sons, Inc., New York; Chapman and Hall, Ltd. London. Price 17s 6d net. Reviewed in *Engineering*, **13** [3412], 725–26 (1931). A.A.

Waterproofing of engineering constructions. VOGELER. *Tonind.-Ztg.*, **55** [67], 958–61; [68], 972–73 (1931).—The German Railroad Co. has issued a booklet on waterproofing the different constructions and buildings used by the Company. Materials and ways to use them are described. Waterproofing of buildings erected in the ground water and above it and tunnels, etc., are described. Illustrated. W.M.C.

PATENTS

Treating dressed-clay slab in the manufacture of brick, etc. H. H. BAILEY. Brit. 354,435, Aug. 19, 1931.

Tile for walls, fireplaces, etc. T. W. ADAMS. Brit. 355,314, Sept. 2, 1931.

Manufacturing ridge tile. J. HUTCHESON. Brit. 355,530, Sept. 2, 1931.

White Wares

Comparative study showing the possibilities of sillimanite for use in extrusion dies. P. W. DAGER AND A. G. BETTELEY. *Jour. Amer. Ceram. Soc.*, **14** [10], 706–708 (1931).

Notes on drying and drier operation. JAMES T. ROBSON. *Jour. Amer. Ceram. Soc.*, **14** [10], 709–15 (1931).

Difficulties in firing white ware. JAMES T. ROBSON. *Jour. Amer. Ceram. Soc.*, **14** [10], 716–24 (1931).

Solution of the modulus of rupture equation by means of a simple four-variable chart. R. G. MILLS. *Jour. Amer. Ceram. Soc.*, **14** [10], 729–32 (1931).

Melting relations of potash feldspar, soda feldspar, and flint mixtures. C. R AMBERG AND J. L. GALLUP. *Jour. Amer. Ceram. Soc.*, **14** [10], 733–38 (1931).

Resistance of single clay bodies to the action of steam. C. L. DEEDS. *Jour. Amer. Ceram. Soc.*, **14** [10], 770–72 (1931).

Shrinkage observations on a porcelain body. M. H. HUNT. *Jour. Amer. Ceram. Soc.*, **14** [10], 773–76 (1931).

Tableware research offers designs in square shapes. ANON. *Bull. Amer. Ceram. Soc.*, **10** [9], 295–301 (1931); *Ceram. Ind.*, **17** [3], 226–27 (1931). W.W.M.

Effects of gaseous hydrochloric acid on porcelain crucibles. N. I. MATVEEV. *Jour. Chem. Ind.* [Moscow], **7**, 388–89 (1930).—Loss of weight of porcelain crucibles when exposed to gaseous HCl at 880° is found to be enough to introduce considerable error in the determination of W. As a probable explanation, formation of $SiHCl_3$ is offered. $SiHCl_3$ is volatile at the temperature of the electric furnace. (*C.A.*)

Melted basalt. ALBERT PORTEVIN. *Mém. soc. ing. civils France*, pp. 266–300 (1928); *Mineralog. Abs.*, **4**, 400.—Basalt when melted and cast in molds and subsequently devitrified by reheating at a carefully controlled temperature yields a material which is especially resistant to mechanical strain and is an excellent electric insulator. This is used in the electric and chemical industries. In the process of melting, partly melted olivine crystals sink, and when cooling begins, long acicular crystals of this mineral separate out in this basalt portion. (*C.A.*)

Preparing raw materials for whiteware bodies. M. PORRMANN. *Sprechsaal*, **64** [32], 589–91 (1931).—The methods for preparing raw materials for whiteware bodies and the machines and installations needed for this purpose are discussed. W.M.C.

Theory and practice of casting ceramic products. Y. I. SHERMAN. *Trans. Kiev Div. Ukrainian Sci. Research Inst. Silicate Ind.* [U.S.S.R.], No. 4, 25 pp. (1930).—In the first part the property of clays and ceramic masses to liquefy by the addition of electrolytes (soda, water glass, etc.) is described and explanations of this liquefying action are given. The second part deals with measuring the fluidity of ceramic masses (the duration of dispersion). To determine the time required for a given volume of slip (100 cc.) to pass a given orifice, S. employed Engler's viscosimeter. As the diameter of the orifice for dispersion in this viscosimeter is small, S. enlarged it to 6 mm. With this change the viscosimeter has been made suitable for measuring the viscosity of ceramic masses. Experiments during 2 years have shown that such a modified viscosimeter is a valuable apparatus for controlling the viscosity of casting slips. The following subjects are discussed: (1) control of hydrogen-ion concentration in casting slips, (2) p_H values, (3) preparation of a casting slip from an unpressed mass, (4) casting fireclay products, and (5) stains on casting products. S.I.P.

Nonsiliceous porcelain with a fluorite base. ANON. *Compt. rend.*, **192**, p. 1237 (1931); *Giorn. chim. ind. applicata*, **13** [7], 344 (1931).—A mass of 25 parts fluorite in the colloidal state obtained by precipitation, and 75 parts natural crystalline fluorite finely ground (screen 120) is dried at 100° and fired at 800 to 1300°. The product obtained has the external characteristics of porcelain. Aluminium fluoride and cryolite, tricalcium phosphate and apatite, and barium sulphate and "barytina" can be combined by this method. M.V.K.

An artist tours the potteries. V. ANON. *Pottery Gaz.*, **56** [651], 1273 (1931).—In this instalment the operation of "placing" saggers in the kiln and methods of winning clay in the mine are described and illustrated. For Part IV see *Ceram. Abs.*, **10** [10], 677 (1931). E.J.V.

High-tension laboratory and works of the General Electric Co., Witton. ANON. *Engineering*, **131** [3410], 669–72 (1931). A.A.

Depression in the British pottery industry. GEORGE A. MAKINSON. *Commerce Repts.*, No. 35, p. 538 (1931).—Exports of pottery in 1930 decreased 20% as compared in value to 1929, while imports gained slightly. Pottery imported is equal to about one-third of the exports, with Germany and Czechoslovakia as the leading suppliers. E.J.V.

Czechoslovakian porcelain industry organizes cartel. SAM. E. WOODS. *Commerce Repts.*, No. 33, p. 408 (1931).—To check declining prices and eliminate useless and excessive competition, 23 Czechoslovakian enterprises operating 31 porcelain factories and employing approximately 13,000 laborers, recently entered into a general sales agreement to regulate domestic prices, the contract being valid until the end of 1933. E.J.V.

German china clay industry. ANON. *Pottery Gaz.*, **56** [651], 1284 (1931).—Business has been poor for the past few months. Sales in part of the industry have remained at the same level as in the first quarter of the year, but most works report a decrease of up to 10% in the quantity of china clay sold. At present, operation is probably not much over 50% of capacity. E.J.V.

Decline in German porcelain sales. WILLIAM E. BEITZ. *Commerce Repts.*, No. 33, p. 408 (1931).—The volume of domestic business of the tableware industry during the first five months of 1931 declined 20% in volume and 33% in value in comparison to a similar period in 1930. Foreign sales of German porcelain tableware have shown a 38% decrease in volume and a 37% decrease in value during this period. E.J.V.

Kahla porcelain factory in 1930. ANON. *Commerce Repts.*, No. 34, p. 485 (1931).—In 1930 the total turnover in table-service porcelain of the Kahla porcelain factory at Kahla, Thuringia, according to value decreased by 13% over 1929 and exports of the firm decreased 38%, although total exports from Germany decreased only 22%. E.J.V.

Porcelain and eathenware plants in Germany. B. BARABASCH. *Ceramics & Glass*, **7** [1], 20–22 (1931).—The latest devices and methods used in the German porcelain and earthenware industry are described. Illustrated. M.V.K.

Thirty years of the government earthenware plant Karlsruhe. ANON. *Sprechsaal*, **64** [33], 607–10 (1931).—A record is given of the exposition of the government earthenware plant at Karlsruhe in Germany which took place in commemorating thirty years of plant work. A number of artistic developments have been made during this time, many new glazes have been tested, etc. Some samples of the fine sculptures are shown. W.M.C.

BOOK

Electrical Insulating Materials. H. WARREN. Price 42s. Reviewed in *Times Eng. Supp.*, **28**, 289 (1931); for abstract see *Ceram. Abs.*, **10** [9], 650 (1931). H.H.S.

PATENTS

Means for supporting baffles in oil-filled bushings. ARTHUR O. AUSTIN. U. S. 18,189, Sept. 15, 1931 (reissue). An insulator comprising a pair of complementary dielectric shells having registering parts, means for clamping the shells together to form a closed casing, a gasket interposed between the registering parts, and a supporting device clamped by the registering parts in contact with the gasket, the device having its outermost portion within the outer periphery of the registering parts.

Making tile. ANDREW MALINOVSZKY. U. S. 1,819,686, Aug. 18, 1931. In a method of making tile, the steps of reducing a glass to a state of fine division, reducing a magnesia-containing material to a state of fine division, mixing and moistening the materials, molding bodies under pressure from the mixture, drying the molded bodies,

and then firing the bodies at a temperature and for a time sufficient to incompletely vitrify the glass.

Insulator. KENT A. HAWLEY AND DAVID H. OSBORNE. U. S. 1,819,748, Aug. 18, 1931. In an insulator of the type in which there is provided an elastic coating interposed between the adjacent surface of a cap and the cement and between the surface of the pin and the cement, the combination of a dielectric body having a skirt portion and an upstanding stem, that portion of the stem adjacent the skirt portion being cylindrical and the remaining portion being reduced in diameter and curved at its end to be of dome shape, the cylindrical portion being roughened, the stem having a recess therein having the innermost portion of its wall roughened, a cap upon the stem and cemented thereto and a pin cemented within the recess, the cap having its lower portion flared outwardly and having its edge inclined downwardly and toward the axis of the dielectric body, the pin having at least one portion of the surface inclined downwardly and toward the axis of the body to accord with the inclined portion of the cap, the inclined edge portion of the cap being located in a plane below the inclined portion of the pin, the roughened portions of the stem and recess wall being staggered and both lying in the field of compressive strain between the pin and cap.

Siphon jet closet. GORDON P. GAVIN. U. S. 1,821,300, Sept. 1, 1931. A siphon jet closet comprising a bowl having a siphon discharge way with a siphon jet nozzle and a flushing rim, a chamber above the siphon having a supply opening, and a passageway from the chamber around the opposite sides of the siphon bend to the space between the legs of the siphon and to the siphon jet nozzle and from the siphon jet nozzle upward and forward along the bottom of the bowl to the front of the flushing rim.

Unit formed partially of fired ceramic material. LLOYD G. COPEMAN. U. S. 1,822,013, Sept. 8, 1931. A refrigerating apparatus comprising a cooling unit formed of stone, one or more of the exposed surfaces of the unit being formed of a fired ceramic material, a refrigerant conducting coil positioned in heat-conducting relation with the fired ceramic material and held in such position by means of plastically applied material adapted to harden without firing.

Toilet bowl. FREDERICK A. SCHOSSOW. U. S. 1,822,378, Sept. 8, 1931. In a toilet bowl, a chamber adapted for connection with a source of water supply, an inwardly overhanging rim channel encircling the bowl having a crenelated lower wall jutting downwardly from the rim provided with substantially horizontal discharge ports adapted to direct the flow of water tangentially over the surface of the bowl below the overhanging rim, an auxiliary water chamber including a conduit adapted to discharge into the basin of the bowl, a passage originating at the top of the rim channel adapted to convey air displaced by flushing water from the channel into the auxiliary chamber, whereby noise due to the escape of entrained air through the rim channel outlets is eliminated.

Insulator. KENT A. HAWLEY. U. S. 1,822,485, Sept. 8, 1931. (1) An insulator comprising a dielectric member, a load-receiving member in spaced relation to the dielectric member, and a body of material interposed between the members and serving to transmit stress from one to the other, the load-receiving member having a working surface whose distance from the dielectric member at a given point as measured in a direction normal to the working surface is approximately proportional to the sine of the angle subtended between the axis of the load-receiving member and the direction of the working surface at the point. (2) An insulator comprising a dielectric member, a load-receiving bolt in spaced relation to the dielectric member, and a body of cementitious material interposed between the bolt and the dielectric member and serving to transmit stress from one to the other; the bolt being provided with a plurality of working surfaces for imparting compressive force to the material, and each of the working sur-

faces being convexly curved and spherical throughout the area thereof by which compressive force is communicated to the material.

Electrical insulator. ALEXANDER NYMAN. U. S. 1,823,502, Sept. 15, 1931. (1) An insulator adapted to form a unit in a series of insulators and to transmit mechanical stress comprising condenser units as compression members composed of alternate sheets of conductive and dielectric material, the units being arranged in arch formation to resist the stress. (2) An insulator adapted to resist a force, and including an electrical condenser, means to transmit the force to the body of the condenser to maintain a suitable pressure thereon, and an additional means to maintain pressure on the condenser.

Pothead for insulated cable terminals. ARTHUR O. AUSTIN. U. S. 1,823,674, Sept. 15, 1931. A pothead comprising a metallic casing, a tubular dielectric member extending into the casing and projecting beyond the end thereof, the casing and dielectric member being connected to form a housing, a second tubular dielectric member disposed within but spaced from the first-named dielectric member and supported on the top thereof and a conductor extending through the metallic casing into the housing.

Insulator with nested parts. ARTHUR O. AUSTIN. U. S. 1,823,676, Sept. 15, 1931. An insulator comprising a plurality of nested dielectric members connected by cement interposed between the members and sheet metal reinforcing members disposed in the joints formed by the cement, an outer reinforcing member being formed of imperforate sheet metal having the surface thereof undulated while an inner reinforcing member is formed of sheet metal having perforations therethrough to permit connecting ties of cement to extend through the inner reinforcing member.

Teapots. BROOKES & ADAMS, LTD., AND A. E. BROOKES. Brit. 354,937, Aug. 26, 1931.

Teapots, coffee pots, etc. T. RHODES. Brit. 355,034, Aug. 26, 1931.

Teapots. H. E. LIMMER. Brit. 355,495, Sept. 2, 1931.

Equipment and Apparatus

Filtering disks of sintered Pyrex glass. W. F. BRUCE AND H. E. BENT. *Jour. Amer. Chem. Soc.*, **53** [3], 990–92 (1931).—A procedure is described by means of which it is possible to prepare satisfactory filtering disks of sintered Pyrex. R.G.M.

Molded form packing for glass containers. ANON. *Amer. Glass Rev.*, **50** [46], 17 (1931).—The new material, made from pulp molded to conform to the general outline of various containers, forms a resilient and light bed for the packing of articles and its cushioned trays provide maximum assurance against breakage in transit. It eliminates the use of hay, etc., and reduces time and labor. E.P.R.

Packing glass containers. ANON. *Ceram. Ind.*, **17** [3], 232 (1931).—Tyte-Pack is the name of a unique method for packing glass containers, developed by the Moulded Pulp Corp., Chicago, Ill. W.W.M.

Spray tower cleans air in new dust collectors. CLAUDE SCHNEIBLE. *Pit & Quarry*, **22** [11], 83 (1931).—S. has manufactured a new multiwash dust collector simplified to eliminate all moving parts, spray nozzles, pockets, and dead zones. E.P.R.

Control of silica dust hazard. ANON. *Stone Trades Jour.; Rock Prod.*, **34** [15], 69 (1931).—Laboratory experiments on control of silicosis in England are described. Dust was caught in a bag filter and sent back into the cabinet in which the tool was working. The results seem to be largely a matter of the design of the collecting hood. The effective area is small with all designs; a flange around the hood helped. W.W.M.

Quantitative humidification of air in laboratory experiments. W. H. J. VERNON AND L. WHITBY. *Trans. Faraday Soc.*, **27** [6], 248–55 (1931).—A method has been

worked out for the preparation of atmospheres of any desired relative humidity. The method depends upon admitting the requisite proportions of desiccated and saturated air into a previously evacuated vessel. Several methods of saturating air have been investigated. Passage of air through vertical columns of water was found to be definitely inefficient; anomalous results were obtained with partially-filled vessels. Complete saturation was rapidly effected by the admission of steam into the air-stream and condensing out the excess under thermostated conditions. Quantitative results at various relative humidities are recorded. G.R.S.

Theory of the coreless induction furnace. WILHELM ESMARCH. *Wiss. Veröffentlich. Siemens-Konzern*, **10** [2], 172–96 (1931).—A theory of the coreless induction furnace is developed which considers the finite length of coil and charge. The calculations of all determinative quantities can be made in a simple and clear manner by means of 2 functions, A and Q, for which curves and tables are given. The quantities calculated according to the theory are accurate to about 2%. The efficiency of a high-frequency furnace is independent of the frequency and is limited only by the geometric proportions of the furnace and the specific material constant (the specific resistance σ and the permeability μ) of the charge, as long as the fusion furnace is always full and the effective resistance of the charge is small in comparison to that of the inductive resistance. If this condition is not filled, the efficiency decreases with decreasing frequency to a constant limit. The power, W_2, received by the charge may be represented by $W_2 = 6.1 \cdot 10^{-10} QA\sqrt{\sigma\mu\nu} \cdot z^2 \cdot kW$, with an error not over 3%; ν is the frequency and z, the ampere turns. A formula is given which specifies the minimum permissible crucible diameter for economical operation at a given frequency. The most important formulas of the theory were experimentally tested and found in good agreement. (*C.A.*)

Science and practice of drying. III and IV. ANON. *Brit. Clayworker*, **40** [470], 86–87; [471], 130–32 (1931).—In the utilization of waste heat for drying, steam and kilns are two sources of heat available in brick and tile works which can be conveniently tapped and made economical in drying. Computations are given to show that the waste heat of the power plant, if all could be recovered, is practically sufficient to dry the brick produced (100,000 wire-cuts) per week during the time the engine is running. The waste heat recoverable amounts to approximately 37½% of the amount required to dry the brick if they each contain 1 lb. of water. The waste heat from continuous kilns is more generally made use of in drying. A kiln loses heat in three ways: (1) by radiation, (2) by cooling of the fired brick, and (3) by the products of combustion. The second loss is of some importance because the more rapidly a continuous kiln is fired the more heat from cooling the ware is available. Computations are given to show that recovery of waste heat from a kiln firing 105,840 brick per week is equivalent to that produced by ½ lb. of coal per min. or about 12½% of the fuel used to fire the brick. The heat leaving with the products of combustion could amount to about 1¼ lb. per minute or about 31% of the fuel necessary to fire the brick. Steam is a wasteful source of heat when generated solely for drying. In the intermittent kiln the total amount of heat passed out of the kiln in the products of combustion is about 50% of that produced by the coal. Computations are given to show that the waste heat of cooling a downdraft kiln is sufficient under controllable circumstances to dry the same quantity of brick as the kiln will fire. A discussion on the removal of the water existing in three states in clay is included. **V.** *Ibid.*, **40** [472], 166–69 (1931).—Curves and data are given on the drying rates of clays from six districts in France. Losses by conduction, radiation, and air leakages are discussed. For Parts I and II see *Ceram. Abs.*, **10** [8], 584 (1931). R.A.H.

Drying of brick. F. LIPINSKY. *Tonind.-Ztg.*, **55** [64], 921–22; [65], 934–35; [66], 945–46 (1931).—Different points in connection with an efficient handling of the

artificial drying of brick are discussed. Possibilities of more rapid drying with moist air than in the usual way are described and curves for both drying processes are given. Plans for drying plants operated by different processes are shown. See also *Ceram. Abs.*, **10** [8], 584 (1931). W.M.C.

Temperature measurement. ANON. *Instrument World*, **3**, 280–81; **4**, 5–6, 27–28 (1931).—The Amer. Inst. of Mech. Engineers is publishing preliminary chapters of a test code on instruments and apparatus. This work is reviewed. H.H.S.

Mechanical handling. C. B. CROCKETT. *Brick Clay Rec.*, **79** [4], 173–74 (1931).—A description of the use of skid racks and power lift trucks for mechanical handling equipment in the M.D. Valentine & Bros. Co. plant at Woodbridge, N. J., is given. Illustrated. See also *Ceram. Abs.*, **10** [8], 590 (1931). E.J.V.

Improved potentiometer pyrometer. LEEDS & NORTHRUP CO. *Brick Clay Rec.*, **79** [4], 178 (1931); *Ceram. Ind.*, **17** [3], 230 (1931).—The "Micromax" pyrometer is more sensitive, more rugged, and faster in operation, is fully automatic, and eliminates daily attention and adjustments due to a new mechanical balancing device and an automatic standardizer which checks the instrument circuit every 45 minutes or less. Details of construction and operation are given. Illustrated. E.J.V.

Chain meter for coal or grain flow. ANON. *Engineering*, **131** [3414], 790–91 (1931). A.A.

Fine testing sieves. P. E. MASTERS. *Engineering*, **131** [3410], 659–60 (1931). A.A.

The neomicrometer. ANON. *Engineering*, **131** [3413], 775 (1931). A.A.

Engineering principles of fans. ANON. *Ceram. Ind.*, **17** [3], 208–12 (1931).—Fan laws for the effect of variations in conditions are given, assuming the efficiency to be constant. Tables of friction losses at varying gas speeds and in various sized pipes, pressures and velocities of air, properties of dry air, and area and circumference of flues of varying diameters are included, as are curves showing characteristics of several types of fans. Air velocity, static pressure, velocity pressure, and total pressure are explained, and the formula for the effect of temperature and barometric pressure on velocity is given. The "specific speed" of a fan of given design is a constant which definitely describes the relation between r.p.m., pressure in inches of water gage, and capacity in cu. ft./min. The best efficiency of the fan operating under any given conditions of r.p.m., capacity, and head will be obtained with a fixed specific speed for a given type of fan. A chart is shown representing data on the relation of horse power to fan wheel diameter and illustrating the effect of wrong diameter at constant r.p.m. Forced draft, induced draft, and requirements of mechanical draft fans are discussed including various types of fans available. W.W.M.

Grinding fines. RICHARD L. CAWOOD. *Ceram. Ind.*, **17** [3], 214–18 (1931).—Modernization of the flint grinding plant of the Potters' Mining and Milling Co. is described. Batch mills were replaced by continuous grinding machinery. Figures on the reduced power and labor costs are given. W.W.M.

Steam-air mixtures. Drying. HANS SCHULZE-MANITIUS. *Feuerungstechnik*, **19** [8], 121–27 (1931).—On the basis of the fact that steam-air mixtures act similarly to complete gas mixtures in their changes of state, S. discusses the problem of drying and treats gas constants for air and steam, apparent molecular weight, gas constant, equation of state, weight, volume, heat content, and heat balance of steam-air mixtures, specific heat and air consumptions during the processes of drying, change in the steam content of air, diagrams for steam-air mixtures, heat balance of drying installations with different possibilities for drying, process of recooling, wasteless process, and efficiency for drying and recooling. A table of the pressure of saturation for steam is given. M.V.K.

Magnetic separator. MAGNETIC MANUFACTURING CO. *Ceram. Ind.*, **17** [3], 232 (1931); for abstract see *Ceram. Abs.*, **10** [6], 445 (1931). W.W.M.

Soft-mud machinery. III. ELIAS PETTS. *Brick Clay Rec.*, **79** [5], 207–10 (1931).—After describing the first pug mill he ever saw, some fifty years ago, P. gives consideration to the machinery required for an efficient soft-mud plant layout, discussing crushers, pug mills, many types of crusher rolls, removal of stones from clay, and other clay preparation equipment. For Part II see *Ceram. Abs.*, **10** [8], 569 (1931). E.J.V.

Polishing metal specimens automatically. AMERICAN INSTRUMENT CO. *Abrasive Ind.*, **12** [9], 37–38 (1931).—An automatic metallographic polishing machine is described, based upon a similar machine, designed by the Bureau of Standards, to effect a standardization of methods employed in polishing specimens of metals for microscopic examination. E.P.R.

Micrometer microscope is designed. R. Y. FERNER CO. *Abrasive Ind.*, **12** [9], 38 (1931).—A new micrometer microscope has been developed by Société Genévoise d'Instruments de Physique, Geneva, Switzerland. Illustrated. E.P.R.

Redesigned table-roller pulverizer. ANON. *Pit & Quarry*, **22** [10], 74 (1931).—The Grindle Fuel Equipment Co. has taken over the manufacture and sale of the table-roller pulverizer previously handled by the Bethlehem Steel Corp. Important changes have been made. E.P.R.

Photoelectric cells in factory inspection. ANON. *Instrument World*, **4**, 2 (1931).—Air-holes, marks, relative colors, faulty caps on bottles, thickness of metal, and many similar phenomena may be detected by whirling articles over a light in front of a photocell. H.H.S.

Prime mover. J. F. J. MALONE. *Times Eng. Supp.*, **28**, 291 (1931).—A liquid, such as water, is used throughout the engine cycle as the thermodynamic medium. The dilatation of the liquid under heat conveys the power. H.H.S.

Study of apparatus for cutting brick, etc. P. RENAULT. *Rev. mat. constr. trav. pub.*, No. 261, pp. 110–13*B* (1931).—Characteristics and details of construction of the pug mills of five French and German factories are shown in tabulated statistics. See also *Ceram. Abs.*, **10** [10], 717 (1931). M.Y.H.

Bucket excavator with Crane conveyer. K. BALDAUF. *Eng. Mining Jour.*, **131** [8], 367–68 (1931).—A chain bucket excavator capable of working two levels simultaneously and discharging into cars is described. C.R.A.

Compressed air sampling. E. ISERN. *Eng. Mining Jour.*, **131** [8], 351–54 (1931).—A sampling device is used successfully at the Tri-State zinc-lead milling plant. Its mechanism is operated by compressed air and is capable of being used for more than one storage bin. C.R.A.

Increasing steam drier efficiency. P. ERIMESCU. *Eng. Mining Jour.*, **131** [12], 553–54 (1931).—A method for removing the resinous encrustation from the interior of the coils of steam driers is described. The cleaning is accomplished by forcing trichlorethylene (C_2HCl_3) through the coils. This dissolves the encrustation. The solvent can be largely recovered by distillation, thus making the process cheap. C.R.A.

Dehydrating of compressed air. ANON. *Sprechsaal*, **64** [32], 591–94 (1931).—Air compressors suck water vapor and air from the atmosphere. Usually water condenses in pipe lines, spraying pistons, etc., when the air is cooled. Calculations are given showing the amount of water which should be removed. Different means of removing moisture content are discussed; one of the best ways is to take out the liquid by a water trap and then to pass the air through silica gel to remove all water and oil vapors. W.M.C.

Feeders for ceramic plants. H. KREMSKI. *Tonind.-Ztg.*, **55** [60], 875–76 (1931).—Different types of feeders for solid, liquid, and pulverized materials are outlined. W.M.C.

Self-aligning bearing. ANON. *Chem. Met. Eng.*, **38** [8], 480 (1931).—The self-aligning spherical mounting for a single heavy-duty Hyatt roller bearing is intended for service where loads exceed those ordinarily met in a line-shaft. G.R.S.

Gage protector. CHAMPION & BARBER, INC. *Chem. Met. Eng.*, **38** [8], 479 (1931).—A gage protector and a "non-pulsator" are protection devices of the above company. G.R.S.

Nonmetallic pipe and fittings. ANON. *Chem. Met. Eng.*, **38** [8], 479 (1931).—Dilecto, a thermosetting plastic material, resistant to acid corrosion, heat, and pressure, has been molded into pipe and fittings. They are available for pressures up to 650 lb. and temperatures to 290°F. Fittings of a different composition are adapted to the resistance of alkalis. G.R.S.

Air thermostat for quantitative laboratory work. W. H. J. VERNON. *Trans. Faraday Soc.*, **27** [6], 241–47 (1931).—Details are given of an air thermostat for maintaining accurate control of temperature over comparatively long periods. Readings on a Beckman thermometer placed in different positions over the whole working space of the thermostat showed a maximum "spatial variation" of 0.015° at a controlled temperature of 25°C. Variations in point of time did not exceed 0.005° (observations extended over a working period of two weeks with the thermometer in fixed position in thermostat; outside temperature varied between 15.5° and 22.5°). A temporary disturbance caused by opening a door of the thermostat to its fullest extent for 3 or 4 minutes, resulting in the temperature falling by 0.03°, was completely eliminated in 20 seconds. G.R.S.

Thermostats. ANON. *Glas App.*, **11**, 156 (1930).—Two new types of thermostat are described. (1) A variable contact D.R.-P. thermometer can be employed for the thermostat and any desired temperature between 1° and 550° retained to an accuracy of 1/10° (provided the contact thermometer is graduated in 1/10° divisions). A tilting mercury cup causes the main heating circuit to be broken or remade, as the upper or lower extent of the permissible variation is reached. (2) The second type, for use only with a variable maximum and minimum thermometer, enables temperatures to be maintained constant between such wide limits as 20° and 30°, an automatic coil arrangement being employed in this instance. (*J.S.G.T.*)

Belt conveyer idlers. ANON. *Chem. Met. Eng.*, **38** [8], 478 (1931).—The idlers are equipped with Timken roller bearings and the pulley shells may be renewed without destroying the pulley ends. Nine sizes are offered. G.R.S.

V-belt drive pulley. AMERICAN PULLEY CO. *Chem. Met. Eng.*, **38** [8], 489 (1931).—Multigrooved pulleys have been developed for V-belt drives of pressed steel, formed in heavy dies so accurately that machining is unnecessary. G.R.S.

Vertical speed reducer. ANON. *Chem. Met. Eng.*, **38** [8], 478 (1931).—The motor gears are of chrome-nickel steel cut with spiral bevel teeth for efficient noiseless operation. All ratios from 8 to 1, to 1600 to 1 are available, and the sizes range from $^1/_2$ to 100 h.p. G.R.S.

Temperature regulator. ANON. *Chem. Met. Eng.*, **38** [8], 477 (1931).—A discussion is given of an accurate on-and-off control of temperature of the nonindicating type regulator. It consists essentially of a thermostat and pilot-operated valve. The principle of the device is shown in a diagram. G.R.S.

Multi-stage valve. ANON. *Chem. Met. Eng.*, **38** [8], 477 (1931).—Each of the five or more land surfaces makes contact with the seat in the closed position thus enabling accurate throttling control and producing a valve which actually improves with use. G.R.S.

Portable gas analyzer. ANON. *Chem. Met. Eng.*, **38** [8], 478 (1931).—The instrument, weighing less than 15 lb., consists of a box in the lower portion of which is a double-

suspended type of galvanometer calibrated in millivolts. The cover of the box contains a thermal-conductivity cell, a small hand pump for flushing out the cell, an absorption tube for analyzing ternary mixtures, and a panel on which its various control dials are mounted. G.R.S.

Lowering costs in lifting process materials. L. B. MURDOCK. *Chem. Met. Eng.*, **38** [8], 468–69 (1931).—A simple, portable electric lifter decreased kiln-loading costs by $5 per day. Variations of the device are shown in photographs and its advantages are pointed out. G.R.S.

Sartorious balance. T. T. COCKING. *Chem. & Ind.*, **50** [33], 696 (1931).—No loose weights of less than 1 gram are used. Eight separate riders weighing 500, 200, 100, 50, 20, and 10 milligrams are used. The balance is easily sensitive to 0.10 milligram. G.R.S.

Streamlined hydrometer. WILLIAM HIERGESELL & SONS. *Chem. Met. Eng.*, **38** [8], 479 (1931).—A torpedo-shaped tip of a new metal-ballasted hydrometer increases accuracy, facilitates cleaning, and reduces the possibility of breakage. G.R.S.

Destruction of chrome and nickel heating elements. ANON. *Chem. Age* [London], **23** [597], 33 (1930).—The colored deposits found on ceramic holders are due to throwing off conductive oxide crusts. The yellow deposits contain chromium trioxide and the brown and greenish deposits contain nickel chromate. Above 900°C the wire produces ozone from the air. In the process of burning out the wires become shorted and produce local heating at that point. C.G.H.

Large and small motors in the modern industrial steam power plant. E. A. MURRAY. *Eng. & Finance*, **25** [1], 7–8 (1931). R.G.M.

Modern mill and pulverizing methods. W. H. D. SUTHERLAND. *Chem. Age* [London], **22** [560], 265 (1930).—The reduction of all kinds of materials to various degrees of fineness and also the blending of (1) solids, (2) solids and liquids, and (3) liquids are discussed. A description and the uses of the following mills are given: (1) swinging hammer pulverizer for medium fine grinding, (2) "kek" mill for fine dry grinding, and (3) the circulator mill for wet grinding. C.G.H.

Spray gun. BINKS MFG. CO. *Metal Cleaning & Finishing*, **3** [8], 679 (1931).—The new Thor model two-spray gun is made in two models. On one the spray adjustment is made by a removable key, and on the other by a stationary control. A simple turn of the control screw on the back changes the spray from round to fan or fan to round without stopping spraying operations or adjusting nozzles. Illustrated. E.J.V.

New die design. TWOLIK R. LARGURA. *Brick Clay Rec.*, **79** [5], 228 (1931); for abstract see *Ceram. Abs.*, **10** [10], 720 (1931). E.J.V.

Disk feeder. DEISTER CONCENTRATOR CO. *Brick Clay Rec.*, **79** [5], 228–30 (1931).—A feeder with a 60-inch disk surmounted by a 42-inch diameter full-opening drum, driven through a worm gear equipped with ball-thrust bearings and roller bearings, running in oil and encased in dust-proof housing, capable of handling any size of material from 3-inch cubes down to dust, is announced. E.J.V.

Discussion of "Pugging machines and press for wire cutting." O. BALLENTIN. *Sprechsaal*, **64** [31], 572 (1931); see also abstract by C. Dorneddon, *Ceram. Abs.*, **10** [8], 589 (1931). W.M.C.

Multiple-bush hot air and gas pyrometer. WM. GILBERT. *Engineering*, **132** [3418], '63 (1931). A.A.

Hot oil packing. DIAMOND RUBBER CO. *Chem. Met. Eng.*, **38** [8], 479 (1931).—A new grade of asbestos sheet packing for use with hot oil is described. G.R.S.

Gyrator sifter. WOLF CO. *Chem. Met. Eng.*, **38** [8], 479 (1931).—True circular motion of the entire screen surface in the new "Supersifter" is achieved by mounting the sieve box over the gyrator at its center, the entire weight of the sifter being carried

on the gyrating mechanism. Rubber agitators are supported on a subscreen beneath each sieve. G.R.S.

Combination instrument. FOXBORO CO. *Chem. Met. Eng.*, **38** [8], 480 (1931).—A recording, integrating, and flow-indicating single instrument is described and illustrated. G.R.S.

Mercury column gage. AMTHOR TESTING INSTRUMENT CO. *Chem. Met. Eng.*, **38** [8], 480 (1931).—A new mercury column gage measures vacuum and low pressures accurately. G.R.S.

Ratio meter. ANON. *Rock Prod.*, **34** [18], 78 (1931).—The Bailey ratio meter is used as a combustion guide in the firing of gas- or oil-fired heaters, kilns, and industrial furnaces. W.W.M.

General service pump. ANON. *Chem. Met. Eng.*, **38** [8], 479 (1931).—This close-coupled pump, available in 6 sizes, makes use of a minimum number of revolving parts and bearings. G.R.S.

Selection of pumps. ANON. *Brit. Clayworker*, **40** [471], 128–29 (1931).—Among the many important operations involved in clayworking is that of pumping. In general, pumps can be grouped into two broad classifications according to the type of motion involved, *i.e.*, (1) as to whether they bring about motion in a fluid by means of the reciprocating action of a piston or plunger, or (2) by the rotary motion of gears, screws, or some form of rotor or propeller. The direct-acting, centrifugal, turbine, unchokeable types of pumps are discussed and their use for different classes of service are indicated. R.A.H.

BOOK

Foundations for Gas and Oil Engines and Other Machinery. E. L. PARRY. Charles Griffin & Co., Ltd., London. Price 7s 6d net. Reviewed in *Engineering*, **132** [3417], 36 (1931). A.A.

PATENTS

Applying coating. JAMES JARVIS PREBLE AND WAYNE B. THOMPSON. U. S. 1,819,115, Aug. 18, 1931. An apparatus or tool for applying coating material comprising a body having means to admit coating material and a motive agent for discharge therefrom, means for supplementally discharging motive agent upon the main discharge to flatten or spread the same, including a supplemental motive-agent passage in the body, a hollow element having a continuous annular groove in one end face and adapted to communicate with the supplemental passage, a pair of opposed jet members upon its opposite face and communicating with the groove, and locking means for the hollow element.

Applying coating. JAMES JARVIS PREBLE. U. S. 1,819,116, Aug. 18, 1931. A tool for applying coating material having, in combination, an inner nozzle and an outer nozzle provided with a circular series of apertures, the apertures in both series radiating from a common point in the longitudinal axis of the tool, and a third circular series of apertures radiating from a common point in the longitudinal axis of the tool, the points being spaced apart with both the nozzles between them.

Applying coating material. JAMES JARVIS PREBLE AND WAYNE B. THOMPSON. U. S. 1,819,117, Aug. 18, 1931. An apparatus or tool for applying coating material comprising a body having means to admit coating material and a motive agent, an inner nozzle through which the coating material is discharged, an outer nozzle through which the motive agent is discharged, means for supplementally discharging the motive agent upon the main discharge to flatten or spread the same including a supplemental motive-agent passage in the body, the outer nozzle having a continuous annular groove in one end face and adapted to communicate with the supplemental passage, a pair of opposed

supplemental jet members upon its opposite face and communicating with the groove, and locking means for the outer nozzle.

Sandblasting apparatus. WILLIAM O. LYTLE. U. S. 1,819,331, Aug. 18, 1931. Sandblasting apparatus comprising a table for supporting an article to be marked and provided with an opening, a stencil plate in such opening at substantially the level of the table, vertically movable means having a face of soft material also lying in the opening and surrounding the plate with the face held yieldingly above the surface of the plate, a nozzle beneath the plate in line therewith, and means whereby abrasive under air pressure is supplied through the nozzle.

Brickmaking machine. ROY P. M. DAVIS. U. S. 1,819,740, and 1,819,741, Aug. 18, 1931. (1) In a brickmaking machine, a hopper having an upper mouth portion and a lower wak-forming portion, means for feeding brickmaking material to the hopper, and intermediate means of substantially greater length than the length of the hopper and having a portion only within the hopper for reshaping the flowing mass of material before it reaches the lower or wak-forming portion of the hopper. (2) A brick machine comprising a frame, a relatively thick smooth liner plate, spaced anchoring ribbons extending from the rear corner edges of the plate and attached to the frame, means for slidably supporting a mold and a pallet in contact, respectively, with the upper and lower surfaces of the liner plate, and means for engaging the pallet whereby when the mold is pushed across and beyond the end of the plate and out of contact therewith, the pallet will move correspondingly and the mold will be deposited on the pallet.

Furnace. CHARLES LADD NORTON, JR. U. S. 1,820,028, Aug. 25, 1931. A fuel-fired furnace comprising upper and lower blocks of refractory material, the lower block having a substantially vertical passage diverging upwardly from a point adjacent the lower end thereof to an enlarged portion providing a working chamber in the upper end of the passage, the upper block being adapted to rest on the lower block and having a passage providing a flue extending from the working chamber through this upper block to the atmosphere, this upper block having refractory material spanning the upper end of the working chamber for retaining heat therein.

Metallic refractory material. JOSEPH G. DONALDSON AND HENRY L. COLES. U. S. 1,820,966, Sept. 1, 1931. An alloy including tungsten in amount between 95 to 48%, silicon 0.5 to 45%, and nickel between 1 to 5%, the nickel content being substituted for an equal amount of the silicon.

Measuring apparatus. DAVIDGE H. ROWLAND. U. S. 1,822,458, Sept. 8, 1931. (1) In an apparatus of the character described, the combination of a conduit adapted to have a column of fluent material of constant height passed therethrough at constant velocity, means for applying pneumatic pressure upon a portion of the area of the column whereby the pressure will be directly proportional to the density of the column, and means for visually indicating variations of pressure. (2) The method of determining the density of a constantly moving column of constant length under constant pressure, consisting in opposing pneumatic pressure to the movement of the column and measuring any variations in the pressure.

Casting metals and ceramic masses according to the centrifuging method. CURT FRITZSCHE. U. S. 1,823,037, Sept. 15, 1931. An apparatus for carrying out the casting method comprising in combination with a centrifuge consisting of a stationary frame and a rotatable arm, an electric muffle furnace on the arm having a central space, a two-part mold arranged on the bottom of the central space concentrically to the center axis of the electric furnace and having in its upper part a central funnel-shaped charging aperture adapted to accommodate the material to be melted, electric-resistance heating bodies on the bottom, ceiling, and side walls of the furnace around the mold adapted to uniformly heat the central space and therefore the mold and the material in the funnel-

shaped aperture of the upper part of the mold, collector rings on the shaft of the centrifuge, leads connecting the collector rings with the electric heating bodies, a source of current, brushes for supplying current to the collector rings, wires connecting the brushes with the source of current, and an adjustable resistance in the wires.

Grizzly and screen for grading materials. WILLIAM ROSS. U. S. 1,823,126, Sept. 15, 1931. A grizzly or screen comprising endless chains, bars supported by the chains, and bars pivoted to the chains, the ends of the first-mentioned bars being eccentrically located in apertures in the chains.

High-temperature thermocouple. HENRY C. STAEHLE. U. S. 1,823,706, Sept. 15, 1931. A thermocouple, the elements of which are tantalum, carbide, and graphite, respectively.

Extruding plastic materials. ERINOID, LTD., AND A. LEGGAT. Brit. 354,837, Aug. 26, 1931.

Presses for molding tile, etc. G. WRIGHT AND W. BOULTON, LTD. Brit. 355,451, Sept. 2, 1931.

Shaker sieves, etc. R. HERRMANN. Brit. 355,554, Sept. 2, 1931.

Drying ceramic goods, etc., in channel driers. STETTINER CHAMOTTE-FABRIK A.-G. VORM. DIDIER. Ger. 525,155, Jan. 12, 1927. The temperature of the drying gases, which move countercurrent to the goods, is regulated so that when the gases have become saturated with water vapor, their temperature has fallen below 100°. (*C.A.*)

Kilns, Furnaces, Fuels, and Combustion

Accidents involving powdered coal. D. B. COLEMAN. *Rock Prod.*, **34** [18], 64–66 (1931).—C. suggests methods for preventing formation of coal dust and its ignition and gives instructions in case of fire. W.W.M.

Dust removal from industrial gases by the Cottrell process of electrical precipitation. C. W. HEDBERG. *Proc. Eng. Soc. W. Penn.*, **47**, 63–106 (1931).—Cottrell plants for detarring coke-oven gas consist of a number of 6- or 8-in. pipes, 9 ft. long, in each of which hangs a weighted rod. The gas passes down outside the pipes and up through them. The power consumption is 5 to 8 kw.-hr. per 10^6 cu. ft. of gas. They are installed after the primary coolers. Precipitators for the removal of "fly-ash" from powdered-fuel steam plants are usually placed between the fan and the stack. Large units are employed of two sections in series each with 8 to 15 ducts with wire discharge electrodes separated by reinforced concrete slabs. The power consumption is about 5 kw.-hr. per 10^6 cu. ft. of gas cleaned; a single precipitator can deal with the gases corresponding to a steam output of 500,000 lb./hr. The primary cleaning of blast-furnace gas leaves a dust content of 0.1 to 0.5 grain per cu. ft. Such gas can be used as steel mill fuel if the content is reduced to 0.01 grain per cu. ft., which is possible by the Cottrell process; it may then be used also for gas engines. The process is attractive in cases where water is scarce or difficulties occur with effluents. In working such plants it is desirable to add 25 to 30 lb. of coal to the furnace per ton of Fe, as the hydrocarbon vapors prevent "back ionization." Single-unit precipitators of the powdered-fuel type are used and the temperature should not much exceed 280° or insulator failures become frequent. Such hot dry-cleaning may save 5% of the total heat in the gas. Where cooling is permissible, as when the gas is required for gas engines, initial spray-cooling followed by electrical precipitation is a cheaper process. Plate-and-wire or pipe precipitators are then used. Another lay-out uses two precipitators in series, each preceded by a cooler. (*B.C.A.*)

Dust recovery from rotary driers in coal-preparation buildings. E. H. DE CONINGH.

Rock Prod., **34** [17], 88–90 (1931).—Two installations of dust-control equipment in coal-preparation buildings are described. Descriptions of the equipment used and data on results obtained are given. Besides overcoming the dust nuisance the machinery more than pays for itself. Illustrated. See also *Ceram. Abs.*, **10** [2], 134 (1931). W.W.M.

New kiln-type burner. MAXON PREMIX BURNER CO. *Gas Age-Rec.*, **68** [9], 325 (1931).—Construction and operating details are given of a new burner in which the air is entrained by the positive pressure of the gas stream rather than by the negative pressure of the kiln stack. Illustrated. E.J.V.

Continuous kilns for firing clay products. J. WILLIAMS. *Trans. Ceram. Soc.* [Eng.], **30** [1], 21–33 (1931).—For firing common brick the "Manchester" kiln, an improved Hoffman type, is extensively used because of its simple construction, ease of operation, cheapness of construction, and use of cheap fuel. A detailed description is given of many types of continuous kilns. C.G.H.

Experimental firing of a Scottish fireclay material. A. T. GREEN AND A. E. J. VICKERS. *Trans. Ceram. Soc.* [Eng.], **29** [7], 169–81 (1930).—Economical firing of different fireclay products shows wide differences. A knowledge of the firing properties of the particular raw material is essential. A method of establishing the watersmoking period is described. The authors discuss their experimental firing and some correlation is made between strength and vitrification of brick. C.G.H.

Heat of formation of water and the heats of combustion of methane and carbon monoxide. FREDERICK D. ROSSINI. Bur. Stand., *Jour. Research*, **7** [2], 329–30 (1931); R.P. 343.—This is a correction applying to the report by the same title (see *Ceram. Abs.*, **10** [4], 307 (1931)). R.A.H.

Effect of firing conditions on the soluble salt content of clayware. F. L. BRADY AND E. H. COLEMAN. *Trans. Ceram. Soc.* [Eng.], **30** [5], 169 (1931).—Calcareous clay free from pyrites shows little variation in sulphate content at various temperatures when fired in air. When sulphur dioxide is added to the kiln atmosphere there is a marked maximum at about 700°C. A large portion of the sulphate is still found after firing to 1100°C. Pyritic clay shows a well marked maximum at 700°C. C.G.H.

Practical observations on firing downdraft kilns. M. PIERRE DE GROOTE. *Brit. Clayworker*, **40** [472], 170–71 (1931).—Experience has proved that the majority of downdraft kilns may be fired much more rapidly than usual without effect on the ware. To fire a kiln more quickly it is necessary to supply a larger number of heat units in a given time. Sufficient power must be provided by the chimney to overcome the resistance encountered by the air supplied for combustion and by the products of combustion. Grate surface, nature of fuel, dimensions of chimney, and density of setting goods must be studied. G. discusses these features in detail. R.A.H.

Choice of brick kiln for small output. B. HELAN. *Stavivo*, p. 338 (1930).—For an annual capacity of 200,000 brick, combined chamber or partial round kilns are most suitable. For an annual capacity of 200,000 to 500,000 brick, a partial or complete round kiln is best. A small round kiln called "Lilliput" is built in Czechoslovakia for a capacity of 250,000 brick per year. This kiln, however, is not suitable for the production of thin-walled products. R.B.

Output of ring kilns. A. REZÁČ. *Stavivo*, p. 336 (1930).—R. discusses the so-called resistances met with in kilns whereby the draft is lowered. He draws attention to the importance of heat transmission by radiation and direct contact of the layers in the kiln. This is essential to rapid progress and is often neglected. R.B.

Oil fuel and the brick industry. I. LUBBOCK. *Trans. Ceram. Soc.* [Eng.], **30** [2], 68–80 (1931); for abstract see *Ceram. Abs.*, **10** [7], 518 (1931). C.G.H.

Factors to consider in buying fuel oil. II. ANON. *Brick Clay Rec.*, **79** [3], 129

(1931).—While high viscosity oils require larger apertures in the burners it is generally best to use the highest viscosity oil that the particular installations will handle without clogging and without difficulty in feeding through the burners. III. *Ibid.*, **79** [5], 213 (1931).—Fuel oil with less than 0.5% sulphur should be specified if the combustion gases contact the ware. With tight muffles, sulphur content up to 1.5% would not necessarily be objectionable. Paraffin base oils contain about half as much sulphur as asphaltic base crude oils. For Part I see *Ceram. Abs.*, **10** [10], 723 (1931). E.J.V.

Mechanism of combustion of individual particles of solid fuels. D. F. SMITH AND A. GUDMUNDSEN. *Ind. Eng. Chem.*, **23** [3], 277–85 (1931); for abstract see *Ceram. Abs.*, **9** [12], 1083 (1930). R.G.M.

Gas fuel minimizes tile rejects. J. B. NEALEY. *Ceram. Age*, **17** [6], 306–308 (1931).—N. describes the operation and equipment of the Federal Tile Co., which uses coal, oil, and gas. When using coal only 40 to 50% Class A tile were obtained; with oil this was increased to 60%; but with gas more than 80% Class A tile is being produced. R.G.M.

Flame temperatures of hydrocarbon gases. G. W. JONES, BERNARD LEWIS, J. B. FRIAUF, AND G. ST. J. PERROTT. *Jour. Amer. Chem. Soc.*, **53** [3], 869–83 (1931); for abstract see *Ceram. Abs.*, **9** [12], 1084 (1930). R.G.M.

Effect of sodium carbonate on the gasification of carbon and production of producer gas. D. A. FOX AND A. H. WHITE. *Ind. Eng. Chem.*, **23** [3], 259–66 (1931).—No great advantage is indicated in the use of sodium carbonate in a water-gas machine operated according to the usual procedure. R.G.M.

Gaseous combustion in industry. R. V. WHEELER. *Chem. & Ind.*, **50** [27], 550–54 (1931).—An example is pointed out of the value of researches on gaseous combustion to industry. A discussion is given of flame speeds. The assumptions founded on experiment that must be made in these calculations are (1) that mixtures of "limit" mixtures are themselves limit mixtures, subject to the restriction that they are all of the same type, *i.e.*, all lower-limit mixtures with excess of air or all upper-limit mixtures with excess of combustible gas, (2) that mixtures of "equal flame-speed" mixtures, subject to similar restrictions, have themselves that flame-speed, (3) that mixtures are themselves maximum flame-speed mixtures with a speed of flame that can be calculated by simple proportion from the speeds of flame of the component mixtures. Speed-percentage graphs are given for different mixtures of gases. The effects of the following diluents are discussed: nitrogen, helium, carbon dioxide, and water vapor. Graphs show the ranges of inflammable mixtures of these gases with air, methane, and hydrogen. G.R.S.

Analysis of flue gases and heat balance of cement kilns. A. NILSSON. *Tonind.-Ztg.*, **55** [62], 901–902 (1931).—Formulas for calculating the composition of flue gases and a determination of the heat balance of cement kilns are given. W.M.C.

Natural gas. A. H. HUBBELL. *Eng. Min. Jour.*, **131** [10], 453–58 (1931).—With the recent activity in the production of natural gas, the advisability of its use as a commercial fuel becomes important. H. discusses its merits and gives data on its availability and comparative costs. C.R.A.

Effect of an electric field on flames and their propagation. B. LEWIS. *Fuel Sci. Practice*, **10** [7], 297–302 (1931); *Jour. Amer. Chem. Soc.*, **53**, 1304 (1931). R.G.M.

Effect of electric field on the propagation of flame. E. M. GUENAULT AND R. V. WHEELER. *Fuel Sci. Practice*, **10** [7], 302–307 (1931). R.G.M.

Influence of mineral constituents on the combustion of solid fuel. B. MOORE AND G. J. WEVELL. *Chem. & Ind.*, **50** [28], 229–42 (1931).—Calculated rates of formation of CO_2 show that (1) at 425° the reactivities of all the added compounds increase the reactivity of the coke, (2) at 365° only the addition of $CaCl_2$ reduces the reactivity of the

coke, and (3) at 305° only the addition of K_2CO_3 and $CaCl_2$ reduces the reactivity. The relation with time of the quantity ($CO_2 + {}^1/_2CO$) ÷ total (O_2 − O_2 "fixed") and relation with time of total O_2 consumed are discussed. The highest reactivity is manifested in most cases by the cokes which have been impregnated with the salts of the alkali metals. Inorganic compounds appear to confer high reactivity on the coke. CO content of the reaction products is generally small except in the case of one or two cokes, notably the "NaCl" coke. The temperature-reactivity relation indicates that for the most reactive cokes there appears to be a critical temperature (about 350°) corresponding with a marked decrease in the rate of increase of reactivity. G.R.S.

Notes on reducing atmospheres. ANON. *Brit. Clayworker*, **40** [470], 88–90 (1931).—Reducing gases used to give the color effects in multicolored brick and tile are discussed in detail. The following precautions are listed as being of importance when making use of reducing gases during the firing of brick: (1) All leaks in the structure of the kiln should be closed. (2) If it is necessary to add fuel to the fires during the reducing period, the damper should be closed during the stoking. (3) The use of tar, damp leaves, brushwood, etc., is seldom necessary, as the reducing gases can be produced equally well with coal if the firing is properly controlled. (4) To ensure good reduction, the fire boxes should be deep and fitted with grates, the fuel being supplied from above. (5) An excess of draft during the reduction must be avoided. (6) There is usually a large fall in temperature during the reduction, and this may prevent the requisite changes in color from occurring. To avoid this the fires should be kept burning brightly some time before the reduction is commenced. (7) The ware must be at a sufficiently high temperature before starting the reduction, but it must not have commenced to sinter or vitrify or the reducing gases will be unable to enter the pores in the brick. R.A.H.

Notes on firing blue brick ovens. W. EMERY. *Brit. Clayworker*, **40** [471], 152–58 (1931).—A description is given of the furnace and materials used in a plant of a North Staffordshire (England) manufacturer, for the manufacture of "blue engineering brick, etc." A study of settings, oven contents, fuel, etc., was made and the results obtained with a discussion of them is included. R.A.H.

Use of fuel oil. ANON. *Brit. Clayworker*, **40** [471], 133–35 (1931).—A description is given of the equipment used and the results obtained when using fuel oil for obtaining supplementary heat for drying ware in tunnel or other types of driers. This is an initial installation for this purpose and is used at the Cheriton Brickworks, Folkestone, England. R.A.H.

Fume and grit emission from furnaces. ANON. *Engineering*, **131** [3414], 800 (1931). A.A.

Removal of sulphur compounds from water gas. ANON. *Engineering*, **132** [3423], 221 (1931). A.A.

International Gas Conference. ANON. *Engineering*, **131** [3412], 739–40 (1931). A.A.

Spontaneous combustion of coals. ANON. *Engineering*, **132** [3422], 211–12 (1931). A.A.

Firing drain pipes. A. WIKKO. *Tonind.-Ztg.*, **55** [69], 987 (1931).—The best method of firing drain pipes in Hoffmann kilns is discussed. W.M.C.

Chimneys and ventilators. ALBERTO PELLACINI. *Corriere Ceram.*, **12** [7], 293–97 (1931).—A scientific and practical discussion of the use of chimneys and ventilators in kilns is presented. M.V.K.

Practical data on combustibles. F. FRANCESCHINI. *Ind. Silicati*, **9** [6], 7–14 (1931).—The composition and calorific power of solid, liquid, and gaseous fuels are given. M.V.K.

Kiln leakage through dampers. ANON. *Brit. Clayworker*, **40** [471], 129 (1931).—

A careful measure of the draft of a kiln in different parts of the structure will often reveal a serious leakage at one or more dampers. Leaks in kilns are so wasteful in fuel and have so bad an effect on the control of the firing that they should be searched for frequently and corrected. Bell dampers often leak because the plate on which they rest is dirty and, consequently, air leaks between the plate and the bell. They leak also if worn unevenly or if insufficient sand is provided when a sand seal is used. Plate or sheet dampers often leak because they have been warped by heat or partially burned away. Sheet-iron dampers should not be used if they are expected to resist high temperatures. When a paper damper leaks it is usually because an unsuitable paper has been chosen. A badly made wicket will have a serious effect on the kiln, as will feed-holes and caps which fit imperfectly, and cracks in the brickwork. R.A.H.

BOOK

Industrial Kilns. (Industrieöfen.) **Vol. II.** W. TRINKS. VDI.-Edit., 1931. 398 pp. 20 Rm. Reviewed in *Feuerungstechnik*, **19** [8], 134 (1931).—Volume I was devoted to the theoretical bases of technical kiln construction. Volume II treats the practical side of this question. T. discusses (1) the solid, liquid, and gaseous fuels with their properties, uses, and economies, (2) electrical energy and its use in kilns, (3) the action of kilns and burners with special regard to air-fuel mixtures, (4) means for maintaining uniform kiln temperature and its constant stability in all places of the fire chamber, (5) influence of kiln atmosphere on the firing and calcining of ware and its regulation with different fuels and kilns, and (6) a critical comparison of fuels and kiln systems, the sources of heat energy, the use of waste heat, and kinds of heat transfer. For Vol. I see *Ceram. Abs.*, **10** [10], 724 (1931). M.V.K.

PATENTS

Gas producer. FRED B. CROSBY. U. S. 1,822,885, Sept. 15, 1931. In a gas producer, a rotating ash support, an ash-removing plow carried by the support, means normally held in the path of the plow to arrest its rotation with the ash support and thereby cause the discharge of ashes from the producer, and automatic means set in operation upon the arrival of the plow in its arrested position for causing the plow-arresting means to release the plow after ashes have been discharged from the producer for a predetermined interval.

Tunnel kiln for firing refractory ware. C. OTTO & CO. G.M.B.H. Ger. 481,578, Aug. 20, 1927. See following patent. (*C.A.*)

Tunnel kiln. C. OTTO & CO. G.M.B.H. Ger. 520,199, June 24, 1930. Details of operating the kiln by regulating the pressure of the air for combustion and for currents in the cooling zone, for firing fireproof ware, are given. (*C.A.*)

Geology

Crystal structure of the epidotes. I. D. J. BUJOR. *Z. Krist.*, **78** [5–6], 386–411 (1931).—Results of crystallographic research, especially etching tests, piezoelectric and pyroelectric determinations, and the preparation of Laue diagrams show that the crystal class of the epidotes is C_{2h}^3. The unit cell, which contains two molecules of $Ca_2OH(Al,Fe)Al_2(SiO_4)$, has the dimension $a = 8.84$ Å, $b = 5.60$ Å, $C = 10.1$ Å, and $\beta = 115° 23'$. G.R.S.

Structure of vesuvianite. B. E. WARREN AND D. I. MODELL. *Z. Krist.*, **78** [5–6], 422–32 (1931).—From consideration of available chemical analyses and of the crystal structure determined by X-ray analysis, the ideal composition of vesuvianite is found to be $Ca_{10}Al_4(Mg,Fe)_2Si_9O_{34}(OH)_4$. From rotation and oscillation photographs a =

15.63 Å, c = 11.83 Å, c/a = 0.757, space group D_{4h}^{4}, with 4 molecules in the unit cell. A close connection was found between tetragonal vesuvianite and cubic garnet in cell dimensions, space symmetry, and chemical composition. Columns in the vesuvianite structure parallel to c and about 10 Å in cross-section are identical in structure to corresponding regions in the unit cell of garnet. From this relation approximate positions were found for all the atoms in the vesuvianite structure. A set of quantitative measurements of integrated reflexion from about 40 planes (*hkl*) give measured values of amplitude contribution F in good agreement with those calculated from the structure. Both Si_2O_7 and SiO_4 groups are present in the structure; the (OH) ions are not bound to silicon but to 1 Al, 1 Mg, and 1 Ca. The striking similarity which vesuvianite and garnet show in many of their physical properties is readily understood in terms of the close connection between the crystal structures. G.R.S.

Factors affecting soil reaction values as determined by the quinhydrone electrode. B. THOMAS AND F. J. ELLIOTT. *Chem. & Ind.*, **50** [33], 303–306 (1931).—Until a rigid technique has been universally adopted, the results obtained by different workers must be of doubtful value for comparative purposes. An investigation is described involving a detailed examination of the effect of soil-water ratio and weight of quinhydrone on p_H and potential drift. G.R.S.

Earth resistivity surveying. G. F. TAGG. *Eng. Mining Jour.*, **131** [7], 325–26 (1931).—T. gives a description of the apparatus and methods used in determining the specific resistance of the earth over varying intervals. A change in the specific resistance normal to the native rock indicates the presence of an ore body of some kind. The interpretation of the results is difficult because of the lack of definite mathematical theories but the location of the foreign body can be readily obtained. C.R.A.

Significance of a geophysical exhibition. EDITORIAL. *Instrument World*, **4**, 25 (1931).—The exhibition held in London in June shows that the secrecy which has until recently surrounded the question of electrical instruments for geophysical survey is being lifted. An exhibit of historic interest is a seismoscope made in China 1800 years ago. H.H.S.

Feldspar for ceramics. A. ACKERMAN. *Ceram. Age*, **17** [6], 325–27 (1931).—A. presents details of the origin, history, and development of feldspar. See also *Ceram. Abs.*, **10** [5], 381 (1931). R.G.M.

Tectonic history and chemical composition of feldspars. E. TRÖGER. *Sci. Prog.*, **26**, 27 (1931).—Statistical study of 416 analyses shows that in the feldspars the amount of the anorthite molecule varies directly with the intensity of folding, a relation which so far remains unexplained. H.H.S.

Nevada feldspar operation. ANON. *Rock Prod.*, **34** [18], 43 (1931).—Feldspar of Nate Kearns and Sons, near Peavine, is surface-mined and hauled 10 miles to the nearest railroad for $7.95 per ton F.O.B. W.W.M.

Canadian nonmetallic minerals production, 1930. ANON. *Can. Chem. Met.*, **15** [8], 227 (1931).—Quebec and Ontario produced 17,074 T. and 9722 T., respectively, of feldspar, a decrease of 28.5% from 1929 totals. The quartz production from 26 quarries in four provinces of 226,200 T. also showed a decrease as 1929 production amounted to 265,949 T. E.J.V.

Gypsum production in Canada. ANON. *Can. Eng.*, **61** [6], 12 (1931).—Nova Scotia is the largest producer of gypsum in Canada. Important developments in the industry during 1930 are given. See also *Ceram. Abs.*, **10** [3], 173 (1931). G.R.S.

Diatomite in Ontario. ANON. *Can. Chem. Met.*, **15** [8], 227 (1931).—Arrangements are almost complete for the exploitation of the diatomaceous mud of Lakes Lee and Slocomb, in the Muskoka district, by a method which will yield a competitive product of high and regular quality within easy reach of a large market. Production will start

this fall. A description of the occurrence and method of working the deposit is given. E.J.V.

Diatomite, 1930. ANON. *Can. Chem. Met.*, **15** [8], 227 (1931).—Shipments of diatomite from East New Annan, Nova Scotia, Muskoka Falls, Ontario, and Quesnel, British Columbia, amounted to 554 T., valued at $13,247 in 1930, as compared with 429 T. worth $10,330 in 1929. E.J.V.

Diatomaceous earths produced in Japan for filtration of sugar solutions. T. TANNO AND M. ODAGIRI. *Chem. News*, **142** [3714], 390 (1931).—Chemical composition and some physical properties of 9 Japanese diatomaceous earths were compared with those of the 4 kinds of the supercells imported from the U.S., and the mechanical structure of the representative cells of each earth were also examined under the microscope. G.R.S.

Tchirikov fire clay. N. M. STRALETZ. *Ceramics & Glass*, **7** [4], 31–33 (1931).—S. describes the results of investigations made on different kinds of Tchirikov fire clays. The diversity of their mechanical and chemical composition and the comparatively large content of silica are to be considered as negative properties of the clay. It possesses sufficient plasticity and refractoriness which, with other properties, show that it can be used for fine ceramic production (faience) and for the manufacture of saggers. M.V.K.

Base exchange and the formation of coal. W. H. A. PENSELER. *N. Z. Jour. Sci. Tech.*, **12**, 284–95, 363–75 (1931).—McKenzie Taylor, on work done in Egypt on the Nile delta, advanced the theory (1926–28) that the controlling factor of coal type is bacterial decomposition under special conditions of base exchange and hydrolysis. P. examines this theory with regard to N. Z. coals and is unable to accept it. Fusain is formed before the "roof" is deposited. H.H.S.

Geological history of coal. H. G. A. HICKLING. *Fuel Sci. Practice*, **10** [5], 212–32 (1931). R.G.M.

Jugoslavia magnesite resources and production. EMIL KEKICH. *Commerce Repts.*, No. 34, pp. 479–80 (1931).—Magnesium carbonate occurs in abundance in Jugoslavia in several localities, *viz.*, in veins and pockets in serpentine, beginning in the center of the Bosnia district, going eastward in western Serbia, dividing into two main directions near Cacak, one running northward to Avala and the other inclining to Kraljevo and South Serbia and extending to Greece. The deposits of Uzice and Valjevo are well known. Only calcined magnesite was exported in 1930. Some details of production and methods of development are given. E.J.V.

Kieselguhr in French North Africa. ANON. *Brit. Clayworker*, **40** [471], 149 (1931).—The exploitation of kieselguhr was started in 1909. In 1920, Algerian exports from this property approximated 1200 T., which has gradually increased until now it has reached over 10,000 T. per year. R.A.H.

BOOKS AND CIRCULARS

Physical Properties of the Soil. B. A. KEEN. Reviewed in *Discovery*, **12**, 202 (1931); see also *Ceram. Abs.*, **10** [10], 728 (1931). H.H.S.

Spectrum Analysis in Mineralogy. A. A. FITCH. Reviewed in *Instrument World*, **4**, 22 (1931); see also *Ceram. Abs.*, **10** [10], 729 (1931). H.H.S.

Geophysical Abstracts. XXVII. F. W. LEE. Bur. Mines, *Information Circ.*, No. 6528, 33 pp. Abstracts of German patents concerning electrical methods of geophysical prospecting only, issued since 1904 are presented. For Part XXVI see *Ceram. Abs.*, **10** [10], 730 (1931). R.A.H.

Zircon (the gem). E. P. YOUNGMAN. Bur. Mines, *Information Circ.*, No. 6465, 20 pp. The report reviews the history of the gem, describes properties, color, cutting,

and substitutes and gives data on distribution, mining production, and prices. See also *Ceram. Abs.*, **10** [10], 730 (1931). R.A.H.

Emeralds. I. AITKENS. Bur. Mines, *Information Circ.*, No. 6459, 18 pp. Information is given on properties, occurrence, mining, and preparation of emeralds which consist essentially of aluminium oxide. R.A.H.

Iceland spar and optical fluorite. H. HERBERT HUGHES. Bur. Mines, *Information Circ.*, No. 6468, 17 pp. Iceland spar is a variety of calcite characterized by its purity, transparency, and perfection of crystalline structure. By far the most important use of Iceland spar is for the manufacture of nicol prisms which are an essential part of every polarizing microscope. The report gives other uses of this mineral, geology, mining methods, production methods, occurrences, consumption, prices, markets, etc. The same type of data and information is given with respect to fluorite. R.A.H.

Rhenium (and masurium). PAUL M. TYLER. Bur. Mines, *Information Circ.*, No. 6475, 17 pp. Information is given on properties, identification, analysis, occurrence, extraction and preparation, production and trade, and prospective uses. A bibliography is included. R.A.H.

Chalk, whiting, and whiting substitutes. OLIVER BOWLES. Bur. Mines, *Information Circ.*, No. 6482, 13 pp. The report describes the geological origin of chalk, discusses origin by states, gives details of manufacture of whiting and its uses, and includes data on prices, production, imports, exports, and tariff. R.A.H.

Mineral Industries of Ohio. GEOLOGICAL SURVEY OF OHIO. *Brick Clay Rec.*, **79** [5], 212 (1931).—This directory contains names of the mineral-producing companies in the state and a map indicating locations of these companies. E.J.V.

PATENT

Electrical process and apparatus for the determination of the nature of the geological formations traversed by drill holes. CONRAD SCHLUMBERGER. U. S. 1,819,923, Aug. 18, 1931. An electrical process for determining the nature of the geological formations traversed by drill holes, which consists in measuring the electrical specific resistivity of the formations encountered at different depths inside the drill hole where the hole contains water.

Chemistry and Physics

Rational method of temperature conversion. K. D. DODDS. *Chem. Met. Eng.*, **38** [8], 476 (1931).—Some of the more common equations are given, which are used as a basis for conversion of temperature readings from one scale to another. The merits are discussed of the equation $\frac{F-32}{180} = \frac{C}{100}$, which can be extended to include other scales as Reamur (R), Kelvin (A_K), and Rankine (A_R), and "Z" thermometers. The complete equation is

$$\frac{F-32}{100} = \frac{C}{100} = \frac{R}{80} = \frac{A_K-273}{100} = \frac{A_R-460}{180} = \frac{Z-(\text{f.p.})\text{"Z"}}{(\text{b.p.})\text{"Z"}-(\text{f.p.})\text{"Z"}}$$

The advantages of the use of this general formula are illustrated with several examples. G.R.S.

A test for the ferrous ion. LÁSZLO EKKERT. *Magyar Gyógyszerésztud. Iársaság Értesitöje*, **7**, 231–32 (1931).—By means of the deep red color that Fe^{++} gives with dimethylglyoxime, as little as 0.001 mg. of Fe can be detected. The test can be obtained with lactate or oxalate of Fe. (*C.A.*)

Viscosity of the binary system: $Na_2B_4O_7$–B_2O_3 in molten state. M. P. VOLAROVICH AND D. M. TOLSTOI. *Bull. acad. sci. U.S.S.R., Classe sci. phys.-math.*, pp. 897–906 (1930).—The following results were obtained by the torsion balance method:

B_2O_3 (%)	$Na_2B_4O_7$ (%)	Viscosity (in poises) at 650°	675°	700°	750°
0	100	2180	649	235	49
9.8	90.2	6090	1740	598	111
26.0	74.0	14800	4320	1450	254
29.55	70.45	13800	4230	1490	272
		11000	3390	1200	224
34.0	66.0	9880	3060	1090	206
39.0	61.0	8890	2910	1090	217
		8710	2802	1050	206
40.5	59.5	12700	4020	1470	279
41.5	58.5	8710	2680	975	211
54.5	45.5	5240	1920	816	212
80.0	20.0	793	468	289	130
100.0	0	1510	1130	868	542

Mixtures of maximum viscosity are also those of maximum freezing point and viscosity-composition curves can be used for investigating formation of new chemical compounds. Maximum viscosity is shown by mixtures represented by the formulas $Na_2O{\cdot}3B_2O_3$ and $Na_2O{\cdot}4B_2O_3$. (*C.A.*)

Volumetric determination of uranium. N. H. FURMAN AND I. C. SCHOONOVER. *Jour. Amer. Chem. Soc.*, **53** [7], 2561–71 (1931).—The potentiometric titration of reduced uranium solutions with ceric sulphate or with potassium permanganate is discussed together with the application of the differential method. R.G.M.

Investigations on clay suspensions. RENÉ DUBRISAY. *Chim. & Ind.* [Special No.], pp. 579–86 (1931); see also *Ceram. Abs.*, **9** [9], 790 (1930). (*C.A.*)

A quick determination of silica in alunites. A. M. DYMOV. *Mineralnoe Suir'e*, **5**, 401–404 (1930); *Chem. Zentr.*, **II**, 97–98 (1930).—For technical control analyses the alunite is fused with $KHSO_4$ in porcelain crucibles and the mixture is dissolved in dilute H_2SO_4 + HCl at 70°. Boiling must be avoided because Ti separates out. The precipitate is filtered, washed with hot HCl, dried, and burned. (*C.A.*)

Change of properties of the oxides of iron, aluminum, and chromium in relation to ignition temperatures. P. P. BUDNIKOFF AND K. E. KRAUSE. *Kolloid-Z.*, **55**, 330–33 (1931).—Fe_2O_3, Al_2O_3, and Cr_2O_3 were precipitated from $FeCl_3$, $AlCl_3$, and $Cr(NO_3)_3$ solutions, respectively, with NH_4OH. Complete loss of water was found at 650° for Fe_2O_3, 750° for Al_2O_3, and 850° for Cr_2O_3. The solubility in 2 *N* HCl decreased with increase in the temperature of ignition, Cr_2O_3 being insoluble above 850°, Al_2O_3 13% soluble, and Fe_2O_3 30% soluble. The density increases with the temperature. The oxides ignited at 1000° showed the following densities: Fe_2O_3, 5.195, Al_2O_3 3.729, and Cr_2O_3 5.05. The color of Cr_2O_3 increases to almost black at 300° and then brightens to green again at 650°. (*C.A.*)

Lithium chloroplatinate and the separation of potassium from sodium and lithium by the unmodified original Fresenius method. G. F. SMITH AND A. C. SHEAD. *Jour. Amer. Chem. Soc.*, **53** [3], 947–57 (1931). R.G.M.

Preparation of Seger cones. E. KELLER AND E. GUESLING. *Ceramics & Glass*, **7** [2], 28–29 (1931).—The authors describe new methods used for preparing Seger cones. Data on their composition and properties are given. M.V.K.

Approximate clay analysis. L. R. DAVIES-GRAHAM. *Rock Prod.*, **34** [18], 48 (1931).—D.-G. describes a short method for obtaining approximately the SiO_2 and R_2O_3 contents of clays. No fusion and only 3 to $3\frac{1}{2}$ hr. are required for the analysis. The silica is removed by HF treatment, the ignition loss determined, the CaO and MgO estimated, and R_2O_3 obtained by difference. W.W.M.

Synthetic red oxide. ANON. *Ceram. Ind.*, **17** [3], 206 (1931).—An invention by a Lancashire (England) glass manufacturer of a new process for the production of a synthetic red oxide of iron consists of dissolving scrap iron in weak sulphuric acid to the point of neutrality. The solution is then atomized and dehydrated to ferrous sulphate monohydrate in an evaporator and converted into red oxide of iron in gas-fired furnaces. W.W.M.

Clastic form in size measurement. E. A. HERSOM. *Eng. Min. Jour.*, **131** [9], 403–404 (1931).—H. points out that while screening is the best method of determining particle size, shape cannot be so determined. Since on the shape and surface characteristics of the particles in any screen fraction, depend the total surface exposed, the work necessary to crush, the handling characteristics, quantity of interstitial spaces, etc., some estimation of shape is necessary to interpret screen data correctly. C.R.A.

Physico-chemical properties of clays. H. B. OAKLEY. *Jour. Soc. Chem. Ind.*, **50** [26], 221–22 (1931).—O. criticizes the view of G. Wiegner on the nature of the clay micelle (see *Ceram. Abs.*, **10** [7], 522 (1931)). W. states that saturated clays or those parts responsible for base-exchange phenomena are essentially absorption compounds of silica and alumina and are not chemical individuals or mixtures of these. He mentions the opinion more generally held in Great Britain and America that the base-exchange properties of clays are due to alumino-silicate compounds of quite definite composition. Recent application of X-ray analysis of crystal structure to soil colloids and clay seems to show decisively the presence of crystal lattices and therefore the chemical nature of the binding of silica and sesquioxides in these substances. G.R.S.

Physical and mechanical properties of clay. H. BERRIDGE. *Engineering*, **132** [3420], 126–29; [3422], 192–93 (1931).—Classification of clay for engineering purposes based upon the values of ϵ = pore coefficient, ratio $\frac{\text{(volume of water solidus)}}{\text{(volume of solids)}}$, is suggested. Formulas are given to calculate the various ratios of weight and volume of water to mineral contents. Clay is considered a "disperse system," its two constituents being alumino-silicic acid and the liquid water. Some experiments on determining the conditions of equilibrium are recorded. Desirability of maintaining the "natural" conditions of pressure and moisture content on works of construction is pointed out. The mechanical properties generally encountered are those of a plastic solid, the deformability of which ranges from 1 or 2 to 90 lb./sq. in. in proportion to the water content. It is suggested that the time factor and water content of specimens on which future mechanical tests are carried out should be recorded. Illustrated. A.A.

Diphenylamine as indicator in the determination of iron in silicates. C. J. SCHOLLENBERGER. *Jour. Amer. Chem. Soc.*, **53** [1], 88–98 (1931).—An improved procedure for the determination of ferrous and ferric oxides in silicates is described. Manganese does not interfere in the dichloromate titration with diphenylamine in the presence of hydrofluoric acid, but in the presence of organic matter, results for ferrous oxide may be expected to be high in proportion to the amount of ferrous oxide actually present. R.G.M.

Adsorption of gas mixtures by silica. E. C. MARKHAM AND A. F. BENTON. *Jour. Amer. Chem. Soc.*, **53** [2], 497–507 (1931).—The authors report on an investigation of the adsorption of one gas in the presence of another. Silica was chosen as a suitable adsorbing material. R.G.M.

Rapid colorimetric estimation of potassium. E. R. CALEY. *Jour. Amer. Chem. Soc.*, **53** [2], 539–45 (1931).—C. describes a rapid method for the colorimetric estimation of potassium depending upon its precipitation as potassium picrate by an alcoholic solution of picric acid with the subsequent solution of the separated precipitate in water, yielding a highly colored solution suitable for colorimetric comparison with standard solutions prepared in a like manner from known amounts of potassium. R.G.M.

Kaolins and refractory clays in Italy. IV and V. FRANCESCO SAVELLY. *Corriere Ceram.*, **12** [7], 281–91 (1931).—The installation and equipment of chemical and thermal laboratories for the study of kaolins and clays are discussed. S. enumerates methods of chemical and rational analyses of kaolins and clays. The quantitative analysis includes the determination of hygroscopic water, water of combination, pure silica, alumina, iron, sulphuric acid, sulphates or sulphides, lime, magnesia, titanic acid, and alkalis. The rational analysis of kaolins and clays is given. For Part III see *Ceram. Abs.*, **10** [6], 456 (1931). M.V.K.

Plasticity of Ukrainian kaolins. I. MORATCHEVSKY. *Trans. Ukrainian Sci. Research Inst. Silicate Ind.*, Sci. Tech. Dept. of the Supreme Council Nat. Econ. [U.S. S.R.], Vol. I, 1929.—The plasticity of 14 kaolins was determined by the methods of Zemiatchensky, Lyssin, Stark, Sokolov, Dummler, and Engler, and by estimation of the quantity of hygroscopic water absorbed by the kaolin, the speed of sedimentation of kaolin suspensions, the density of the suspensions, the quantity of water in the mass of normal consistency, the drying shrinkage (at 110°C) and firing shrinkage (at 1410°C), transverse strength of dry samples (briquets), the water absorption of the fired samples, and the average size of the grains. The first three methods give the more exact values of plasticity. Of all the direct methods, M. recommends the Stark method which gave the best results. The tested kaolins can be divided into 3 groups as follows: (1) of high plasticity, 1 kaolin; (2) average plasticity, 7 kaolins; and (3) low plasticity, 6 kaolins. S.I.P.

Heat capacities at low temperatures of manganese sulphide, ferrous sulphide, and calcium sulphide. C. T. ANDERSON. *Jour. Amer. Chem. Soc.*, **53** [2], 476–83 (1931); see also *Ceram. Abs.*, **10** [4], 301 (1931). R.G.M.

Standardized sieving methods. A. PROBERT. *Eng. Min. Jour.*, **131** [7], 311–12 (1931).—P. discusses various methods of making sieve analyses and proposes a successful standard method. C.R.A.

Hydrogen-ion concentration. S. P. L. SORENSEN. *Chem. & Ind.*, **50** [31], 278–81 (1931).—A broad outline is given of the general significance of hydrogen-ion concentration and its measurement. Illustrations of the subject are taken from examples in both science and industry. G.R.S.

Diffusion of electrolytes, nonelectrolytes, and colloidal electrolytes. J. W. MCBAIN AND TSUN HSIEN LIU. *Jour. Amer. Chem. Soc.*, **53** [1], 59–74 (1931). R.G.M.

Report on less common metals in soils. J. S. MCHARGUE. *Jour. Assn. Official Agr. Chemists*, **14**, 138–41 (1931).—The periodate method for determination of Mn is described and recommended. An electric distillation method for determination of iodine in rocks and soils is recommended for study. See also *Ceram. Abs.*, **9** [11], 988 (1930). H.H.S.

Report on potash. L. D. HAIGH. *Jour. Assn. Official Agr. Chemists*, **14**, 213–16 (1931).—The influence of water-soluble phosphates on the determination of K_2O is discussed. A suggestion is made that MgO should be added to remove phosphates. H.H.S.

Report on fluorine compounds. G. A. SHUEY. *Jour. Assn. Official Agr. Chemists*, **14**, 126–32 (1931).—The study of the volatilization method for determining F, continued from last year, has resulted in a tentative official method being here presented. A diagram to scale of the reaction flask is given. See also *Ceram. Abs.*, **9** [11], 988 (1930). H.H.S.

Estimation of fluorine: A study of Travers' method. C. M. SMITH, E. H. HAMILTON, AND J. J. T. GRAHAM. *Jour. Assn. Official Agr. Chemists*, **14**, 253–60 (1931).—Travers (1921) estimated F in aqueous solution by converting it into silicofluoride, filtering, and titrating the silicofluoride. The authors standardize the procedure. Al, Fe, and borates should be absent. H.H.S.

Remarks on calculation. J. KLUG. *Sprechsaal*, **64** [34], 625–28; [35], 643–45 (1931).—K. points out the importance of correct calculation for ceramic plants. Several tables are given showing samples of cards used in different sections of a factory. W.M.C.

Determination of carbon dioxide in soil carbonates. W. M. SHAW. *Jour. Assn. Official Agr. Chemists*, **14**, 283–92 (1931).—Addition of $SnCl_2$ to the HCl used in the evolution method for determining CO_2 prevents interference by any organic matter present. H.H.S.

Separation and identification of the alkali and alkaline earth metals using isoamyl alcohol. H. YAGODA. *Jour. Amer. Chem. Soc.*, **52** [8], 3068–76 (1930). R.G.M.

Selenious acid method for the determination of zirconium. S. G. SIMPSON AND W. C. SCHUMB. *Jour. Amer. Chem. Soc.*, **53** [3], 921–33 (1931).—Zirconium is quantitatively precipitated as basic selenite by excess selenious acid from solutions the acidity of which should not be greater than 0.6 *N*. Hydrochloric acid is the best acid medium for this precipitation. The presence of more than a small amount of sulphate prevents quantitative precipitation of zirconium from hydrochloric acid or sulphuric acid solution. A method for the analysis of zirconium by means of selenious acid is given in detail. A rapid method for decomposing zirconium ores preparatory to making the above analysis is also given. R.G.M.

Plastic flow measurements and their bearing on the plasticity problem. G. W. SCOTT BLAIR. *Trans. Ceram. Soc.* [Eng.], **30** [4], 138–49 (1931); for abstract see *Ceram. Abs.*, **10** [8], 601 (1931). C.G.H.

Expansion measurements of solid bodies up to temperatures of 1400°C. W. M. COHN. *Veröffentlichungen des Kaiser-Wilhelm-Institut für Silikatforschung*, Vol. 4, 41 pp. (1930).—An outline of previous methods for measuring thermal expansion is given. Different methods were developed to measure the thermal expansion of solid bodies between room temperature and 1400°C. For precision measurements, a comparator was built for measuring the expansion directly. By means of this outfit Marquardt porcelain was found to be suitable for a new standard material for temperatures up to 1400°C. For measurement of thermal expansion by the comparison method Marquardt porcelain was used and an apparatus developed which allows measurement up to 1400°C. The measurements may be made visually or by means of photographic registration. A new apparatus was developed for this purpose. See also *Ceram. Abs.*, **10** [5], 368 (1931). W.M.C.

Decomposition of refractory silicates by fused ammonium fluoride and its application to the determination of silica in glass sands. A. C. SHEAD AND G. F. SMITH. *Jour. Amer. Chem. Soc.*, **53** [2], 483–86 (1931).—Molten ammonium fluoride rapidly decomposes powdered quartz and silicates. This reaction is quantitative for glass sand and shows the possibility of opening silicates preliminary to determining other constituents. The method of analysis is given. R.G.M.

Thermal expansion of raw and fired clays. H. SALMANG AND A. RITTGEN. *Sprechsaal*, **64** [24], 447–49; [25], 465–68; [26], 481–85; [27], 501–504; [28], 517–21 (1931).—When raw clay is heated, the following stages are disclosed: (1) a small endothermic reaction between 100°C and 300°C; (2) a strong endothermic reaction between 420°C and 750°C according to the conditions of the experiments; and (3) an exothermic reaction at about 900°C. Below 300°C, water held in physical or colloidal state is given off. The temperature of final dehydration is often too high on account of heating the samples too quickly; the temperature should be about 450°C. The authors believe that the product formed at 450°C is a metakaolin. The exothermic reaction at about 900°C is supposed to break up the metakaolin into sillimanite and γ-alumina; the formation of mullite should not be found at this temperature. Above 1200°C, however,

mullite, which is supposedly formed by an exothermic reaction at this temperature, is always present. Besides mullite, alumina, silica, and glass are present at 1200°C. The authors used raw clays which contained 20% of fine-ground grog in the experiments. As the dilatometer used was made of silica glass, only temperatures up to 1000°C could be reached. A number of curves are reproduced showing the difference in expansion between raw and fired clays against a test alloy. A discussion is given showing that the effects in the curves may be explained by the above-mentioned theories. Some details in the effects encountered are discussed. W.M.C.

Notes on the determination of boric acid. E. SCHULEK AND G. VASTAGH. *Z. anal. Chem.*, **84**, 167–84 (1931).—With the aid of H_2SO_4 and MeOH it is possible to remove all B_2O_3 by distilling off the Me ester. The distillate can be used for the volumetric determination of B_2O_3 with mannitol and phenolphthalein. In the analysis of silicates, the gelatinous H_2SiO_3 is likely to retain a small part of the B_2O_3. For the distillation an apparatus is shown which consists of a long-necked flask with a ground-glass stopper connecting to a dropping funnel and with a gas-exit tube. For 6 to 120 mg. of B_2O_3, add to the substance, which has been placed in the flask and may be in the form of a Na_2CO_3 melt, 30 to 40 cc. of water and 5 cc. of concentrated H_2SO_4. Add a glass bead to prevent bumping and carefully evaporate to dryness, catching the distillate in 10 cc. of *N* NaOH. The condenser tube should not dip into the liquid in the receiver. After the water is all removed, cool and carefully add 40 cc. of MeOH. Now raise the receiver so that the end of the condenser tube rests gently against the bottom of the vessel and carefully distil until SO_3 fumes are evolved and bubbles of gas escape from the receiver. Cool, add 20 cc. more of MeOH and repeat the distillation. Except in the case of silicates, this suffices for the complete removal of all B_2O_3. Sometimes it is necessary to add powdered $CaCO_3$ to prevent bumping. Rinse out the condenser tubing with a little MeOH, make sure that the solution in the receiver is alkaline to methyl orange, add 10 cc. of *N* NaOH in excess and 2 drops of 30% H_2O_2 (H_3PO_4-free) and evaporate carefully in a dish of Ag. This serves to oxidize any SO_2 that may have been evolved. Carefully fuse the dry residue, adding about 1 g. of KOH if necessary in order to obtain a clear melt. This serves to destroy formates or other organic matter. Dissolve the melt in 3 cc. of water, add 2 drops of methyl red solution and add 10% HCl until the solution is acid to methyl red. Transfer to an Erlenmeyer flask, with the aid of a little boiled water, boil 0.5 min. to expel all CO_2, cool, and titrate carefully to the neutral point with CO_2-free NaOH. Now add 1 g. of mannitol for each cc. of liquid and titrate with 0.1 *N* NaOH, using phenolphthalein as indicator. At first the solution will be red, because it is now acid to methyl red, but later it will become yellow and finally at the end-point it will turn pink. The results agree remarkably well. For the microdetermination the procedure is similar but smaller quantities of MeOH are used. (*C.A.*)

BOOK

Electrophoresis, Electroösmosis, Electrodialysis in Solutions. (Elektrophorese, Elektroösmose, Elektrodialyse in Flüssigkeiten.) P. H. PRAUSNITZ AND J. REITSTOETTER. Theodor Steinkopff, Dresden and Leipzig, 1931. 307 pp. Price 20 Rm. Reviewed in *Trans. Faraday, Soc.*, **27** [8], 576 (1931).—The authors deal with both theory and practical application, whether on a laboratory or on a technical scale, in the concise manner of the whole series of "reports," but adequately and critically. The descriptions of technical processes and apparatus give the impression that the authors are not merely abstracting the literature but have personal experience of much of what they describe. G.R.S.

PATENTS

Making precipitated silica. JOHN W. CHURCH. U. S. 1,819,356, Aug. 18, 1931. The process of making precipitated silica, which comprises dehydrating a colloidal solu-

tion of silica gel until it will no longer revert to its former gelatinous colloidal form in the presence of water, wet grinding the dehydrated product, washing, and subjecting the washed product to a second dehydration.

Obtaining beryllium compounds from beryllium-bearing minerals. HELLMUT FISCHER. U. S. 1,820,655, Aug. 25, 1931. The process which comprises comminuting a beryllium-bearing mineral, adding thereto pulverulent alkali metal carbonate used in excess, heating both of the substances together to a relatively high temperature, but below their melting points, for a length of time sufficient to convert the substances into a sintered mass, comminuting the mass, and subjecting it to further treatment for the production of beryllium compounds.

Precipitating titanium compounds. LONNIE W. RYAN. U. S. 1,820,987, and 1,820,988, Sept. 1, 1931. (1) In the precipitation of titanium compounds by hydrolysis from a mineral acid solution containing titanium, the step which consists in mixing the titanium solution and a solution of an organic acid compound at an elevated temperature. (2) In the precipitation of titanium compounds by hydrolysis from a mineral acid solution containing titanium, the step which consists in mixing the titanium solution and a solution of a phosphoric acid compound and an organic acid compound at an elevated temperature.

Industrial treatment of leucite, aluminous potassic and sodic silicates, or of natural and artificial alums to obtain pure alumina, compounds of potassium or sodium, and silica. G. GALLO. Brit. 354,255, Aug. 19, 1931.

Manufacture of compounds containing aluminium and fluorine. A. CARPMAEL. Brit. 354,825, Aug. 26, 1931; see also *Ceram. Abs.*, **9** [9], 793 (1930).

Titanium oxide. METAL & THERMIT CORP. Fr. 702,642, Sept. 25, 1930. TiO_2 is prepared by heating a finely ground mixture of rutile and MgO to form a Mg titanate, acidifying with H_2SO_4, and dissolving in water. The solution is cooled to about 0° to deposit $MgSO_4$, and the mother liquor is heated to a high temperature to form metatitanic acid and to recover H_2SO_4. (*C.A.*)

General

Scope of this Society's activities. EDITORIAL. *Bull. Amer. Ceram. Soc.*, **10** [9], 277–79 (1931).—While members are primarily engaged in making better-quality and lower-cost products through studies of materials, processes, and production quality, they should engage in product development and product promotion. E.J.V.

Productive scholarship. EDITORIAL. *Bull. Amer. Ceram. Soc.*, **10** [9], 279–80 (1931).—A definition of productive scholars is supplemented by the articles of qualification for the rank of Fellow, in which the Fellows define the way they believe that a person shows productive scholarship. E.J.V.

Why this Society. EDITORIAL. *Bull. Amer. Ceram. Soc.*, **10** [9], 280–81 (1931).—After stating that the fundamental objectives of this SOCIETY are "to advance the ceramic arts and sciences by meeting for the reading and discussing of papers, the publication of scientific literature, and other activities," the statement is enlarged upon and some of the "other activities" are explained. E.J.V.

Iowa State offers new course for stiff-mud machine. ANON. *Brick Clay Rec.*, **79** [4], 158 (1931).—A full description of the equipment and objects to be studied in a new laboratory course involving a full-size extrusion machine having three speeds is given. An example of the reports to be made for each run is given. Illustrated. E.J.V.

Open-cut mining of fire clay. H. D. KEISER. *Eng. Mining Jour.*, **131** [7], 303–305 (1931).—The article is a description of the equipment used and the methods of mining and control mold in the A. P. Green mine at Mexico, Mo. C.R.A.

Reducing cost price. ANON. *Rev. mat. constr. trav. pub.*, No. 261, pp. 101–104*B* (1931).—Examples of polyannual statistics in ceramic manufacturing are shown by means of graphs giving the distribution of general expenses, labor, material, and merchandise. M.Y.H.

Refractories and clay products in India. ANON. *Brit. Clayworker*, **40** [470], 110–12 (1931).—The object of this article is to place before the readers the conditions of manufacture of all descriptions of material made and used in India by the clayworker in the several branches of the ceramic industry. Many members of the craft think that such articles as fire brick, silica, and other refractories produced in India, together with salt-glazed pipes, etc., are much below the quality of similar material produced in Europe and America. Such, however, is not the case. Stiff-mud re-press process is favored for fire brick. A blast furnace recently blown produced a millon tons of pig iron with one lining of brick made in India. Silica brick of a good quality are fired at cone 18 in circular downdraft kilns. Magnesite brick are in little demand though some are manufactured. The ore used is so pure that ground iron ore must be added as the binding agent. The raw material of chrome brick is as hard as iron ore and requires heavy mills to grind it. Brick are fired in a square kiln of the American downdraft type. Terra cotta is not made except for occasional fancy purposes. The abundance of marble puts terra cotta out of the market. Glazed wall tile are made in one or two places but they do not compare with the imported material, for which there is a good market. Blue brick are made in one district, but there is not much demand for the native material. Stoneware pipe are produced in several districts, but the glazing is not satisfactory. White-glazed sanitary ware is not made to any extent because the clays in India contain too much iron for satisfactory results to be obtained. R.A.H.

Rational use of steam in the clayworking industries. MARCEL DUPIN. *Brit. Clayworker*, **40** [470], 91–94 (1931).—The article is an exposition of the technical problems involved in the use of steam in brickworks. The conditions to be observed and maintained in order that steam plants may be run economically and to the best advantage are clearly set out and may be easily understood by the nontechnical reader. In order that the reader may readily comprehend what is written, D. divides the subject into the following sections and discusses each separately: (1) vaporization, (2) mechanical utilization of the steam; and (3) thermal utilization of the steam produced and of the heat of the products of combustion of the boiler. R.A.H.

Future of industrial research. FRANK HEATH. *Instrument World*, **4**, 1 (1931).—Industrial research suffers from the chance that a firm may fail to utilize a discovery and that a discovery made in one industry may be useful in another industry and yet be neglected. H. suggests that banks should employ scientific advisers. H.H.S.

Economics of the nonmetallic mineral industries. VII. Cost of sales. RAYMOND B. LADOO. *Rock Prod.*, **34** [18], 41 (1931).—The cost of production has been reduced by improved methods, but little attention has been paid to distribution cost. L. suggests ways of reducing production cost, and discusses factors affecting sales cost. For Part VI see *Ceram. Abs.*, **10** [10], 737 (1931). W.W.M.

Testing the inflammability of mine dusts. ANON. *Engineering*, **132** [3417], 43–44 (1931). A.A.

Control of moisture in ceramic masses. P. P. BUDNIKOFF AND B. I. ENDOVITZKY. *Ceramics & Glass*, **7** [4], 30–31 (1931).—The quality of fireclay ware and the quantity of spoiled ware depend directly on the moisture contained by the mass during production. The existing methods of control are unsatisfactory and do not determine the moisture in large masses. There is a certain regularity existing between the quantity of water contained by the mass and the electrical conductivity. With an increase of water quantity the electrical conductivity grows proportionally. The methods discussed for con-

trolling the moisture, corresponding in each individual case to a definite consistency, permit the determination of the degree of deviation from the normal constant. M.V.K.

Draining the clay pit. ANON. *Brit. Clayworker*, **40** [472], 174 (1931).—All surface water should be drained to one spot and be removed by pumping. The choice of pumps is discussed. R.A.H.

Saving while selling. C. B. PLATT. *Brick Clay Rec.*, **79** [3], 118–19 (1931).—A sales organization to serve a group of manufacturers within a given market area would eliminate duplication of sales effort and reduce cost of carrying stocks. E.J.V.

Nomenclature and classification of ceramic products. FERRUCCIO PALAZZI. *Corriere Ceram.*, **12** [7], 301–303 (1931).—The classification is taken from the publication of a course in ceramic technology of the school of ceramics of S. Salvatore in Lauro di Roma. Ceramic products are divided into two groups according to the method of preparation: (1) simple terra cotta (biscuit) which is fired only once. Under this heading are brick, refractory materials, and ornamental architectural material. (2) Terra cottas which are covered with either a transparent or opaque enamel or glaze and fired at high temperatures. Ceramic products are further classified into two large groups: (1) industrial products made in large quantities by machinery, and (2) artistic objects. The terminology of ceramic products is derived from the quality of the paste. M.V.K.

Ceramists meeting at the Köthen Technical School. ANON. *Keramos*, **10** [12], 317 (1931).—Among the lectures given were the following: "Training engineers for the ceramic industry," by KRAZE; "The advantage of electric power in factories," by METZLER; "Ceramic material in high-tension technique," by RECK; "Measurement of the finest grain size and its value," by LORENZ; "The importance of measurements of tensions between glazes and bodies for industry," by O. LIEBELT; "Making one's own fire brick for repairs in annular kilns," by WEBER; "Use of high-frequency waves in testing ceramic material," by WIGGE; "Heat cost for annular kilns," by KNETSCH; and "Prehistoric ceramics," by GÖTZE. M.V.K.

Heat losses from plant surfaces. R. M. COLLES. *Trans. Ceram. Soc.* [Eng.], **29** [7], 182–90 (1930).—C. describes experiments on radiation and convection losses, and the effect of weather conditions on plant surfaces. The heat losses in still air can be calculated with considerable accuracy from the formula:

$$L_{a+r} = a\left\{\left(\frac{Tp}{100}\right)^4 - \left(\frac{Ta}{100}\right)^4\right\} + b\left(Tp - Ta\right)^{1.25}$$

Where L_{a+r} equals radiation and convection losses in large calories per sq. m. per hr., a is Peclét constant for surface; Tp is temperature of plant surface in degrees absolute; Ta is temperature of surrounding air in degrees absolute; b equals a constant depending on surroundings usually taken as 2.9 in still air. Peclét constants for some of the more common surfaces are as follows:

Aluminum (dull)	2.5	Cast iron (oxidized)	3.0
Aluminum paint	2.3	Wrought iron (oxidized)	2.8
Asbestos cement	3.6	Paint (bright red)	2.5
Brick	3.6	Paint (dark red)	4.5
Copper (dull)	1.2	Rusty iron	2.2–2.9
Copper (highly oxidized)	3.3	Stoneware (chemical)	3.8

See also *Ceram. Abs.*, **9** [4], 315 (1930). C.G.H.

N. J. ceramic exposition. ANON. *Ceram. Age*, **17** [5], 253–87 (1931); for abstract see *Ceram. Abs.*, **10** [6], 467 (1931). R.G.M.

Society of Glass Technology, June Meeting. ANON. *Chem. & Ind.*, **50** [28], 602–603 (1931); *Pottery Gaz.*, **56** [649], 967–71 (1931); *Nat. Glass Budget*, **47** [11], 5

(1931).—A brief report is given of the following papers: (1) "A comparison between the ordinary thermocouple and suction pyrometers for the measurement of the temperature of flowing gases in glass furnaces," by M. PARKIN AND F. WINKS (see *Ceram. Abs.*, **10** [9], 651 (1931)), (2) "Note on the measurement of temperatures of gases in a glass-melting furnace," by J. H. PARTRIDGE, AND A. C. JEFFKINS (*ibid.*, **10** [9], 633 (1931)), (3) "Investigation of the flow of glass in tank furnaces by the use of barium oxide," by E. J. C. BOWMAKER AND J. D. CAUWOOD (*ibid.*, **10** [9], 630 (1931)), and (4) "Density of sodium metasilicate-silica glasses," by F. WINKS AND W. E. S. TURNER (*ibid.*, **10** [10], 685 (1931)). G.R.S.

Society of Glass Technology, May Meeting. ANON. *Pottery Gaz.*, **56** [648], 825–29 (1931).—A discussion of "The constitution and structure of glass" was participated in by Lord Rayleigh, W. L. Bragg, J. T. Randall, AND W. E. S. Turner. E.J.V.

BOOKS

Mechanical Testing. Vol. I. Testing of Materials of Construction. R. G. BATSON AND J. H. HYDE. Chapman and Hall, Ltd., London. 2d ed. Price 21s net. Reviewed in *Engineering*, **132** [3417], 35 (1931).—Introductory chapters are devoted to a summary of the theory of the strength and the properties of material necessary for a sound understanding of the subject matter of the book. These are followed by a description of the better known types of testing machines for tension, compression, torsion, abrasion, indentation, and shock resistance. Use of extensometers for refinement in testing, and the different testing devices used in the testing of timber, brick, stone, cement, concrete, and road materials are described and illustrated. A.A.

Clays and the Ceramic Industries of Texas. A. D. POTTER AND DAVID MCKNIGHT, JR. Univ. of Texas, Bur. of Ind. Chem.; reviewed in *Brick Clay Rec.*, **79** [3], 128–29 (1931).—Interesting data on the clay resources and clay-products plants of Texas are presented. E.J.V.

Catalogue of British Scientific and Technical Books. DAPHNE SHAW. Reviewed in *Chem. & Ind.*, **50** [33], 701 (1931); for abstract see *Ceram. Abs.*, **10** [1], 76 (1931). G.R.S.

Handbook of Commerce in Porcelain, Glass, Household Furniture, and Cooking Utensils. (Das Handbuch des Spezialhändels in Porzellan, Glas, Haus- und Küchengeräten.) WALTER HUTH AND WALTER KÖRTING. 3d ed. Reichsverband Deutscher Spezialgeschäfte in Porzellan, Glas, Haus- und Küchengeräten, Berlin, 1931. 12.00 Rm. Reviewed in *Emaillewaren-Ind.*, **8** [29], 250 (1931).—The industries of glass, porcelain, household furniture, and cooking utensils are discussed. Statistics and data are given. M.V.K.

Book Review

Metallurgical Furnaces. M. A. PAVLOV. 3d enlarged edition. Leningrad, 1931. 103 pp., 22 drawings, 159 figures. Price 2R, 50 kopeks. For a long time furnaces have been called apparatus in which the heat obtained by combustion of fuel was used for some purpose. Metallurgical furnaces were those in which the heating of the treated materials to that temperature at which the proper metallurgical process could take place by combustion of fuel was accomplished. After the introduction in metallurgical engineering of Bessemer's converter and later, the electric furnace, *i.e.*, an apparatus in which fuel is not consumed, the old definition of the furnace became incorrect. P. considers that the best classification of furnaces should be based on the type of fuel used.

The book is divided into three parts: (1) Description of furnaces. According to his classification, P. describes furnaces for (*a*) hard fuel, (*b*) liquid fuel, (*c*) hard pulverized

fuel, (*d*) gas fuel, and (*e*) working without heat, *e.g.*, furnaces for the calcination of sulphur ores, converters, and soaking pits. (2) Utilization of heat in furnaces. P. describes how to calculate the coefficient of utilization for shaft, reverberatory, crucible, and gas furnaces and converters. (3) The selection of a furnace and the determination of its dimensions.

Written by a well-known Russian authority on metallurgy, this book can be recommended as a standard work on metallurgical furnaces. SELICK I. PERKAL

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BULLETIN

of the

AMERICAN CERAMIC SOCIETY

A Monthly Publication Devoted to Proceedings of the Society, Discussions of Plant Problems, Discussions of Technical, Scientific, and Art Questions, and Promotion of Coöperative Research

Edited by the Secretary of the Society Assisted by Officers of the Industrial Divisions

WALTER P. SUTER MYRTLE M. FRENCH	Art	A. E. R. WESTMAN DOROTHY A. TEXTER	Refractories	HOWELLS FRÉCHETTE	Structural Clay Products
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Vol. 10 **November, 1931** **No. 11**

EDITORIALS

HONORING PRESIDENT ESKESEN

Members of this SOCIETY have a keen interest in him who serves as their President. Their confidence and esteem were expressed in choosing him as their executive leader. To be unanimously elected President, the choice of both nominating committees, as was Eckardt Victor Eskesen, by an organization of over twenty-five hundred members is a rare sort of recognition of ceramic attainments and executive ability.

Our President Eskesen is also president of a combine of three companies known as the Federal Seaboard Terra Cotta Company. He is director in two other ceramic plants and in a bank. He is president of realty companies.

It was neither luck nor influence that resulted in Mr. Eskesen's being the executive head of these several business and industrial enterprises: it resulted from faithful and intelligent application of himself to the tasks of mastering the technical details of manufacturing and of business.

An immigrant without money or influential friends, unfamiliar with terra cotta making, he became the master mind and hand because he learned the details through personal experience and study. His mastery of the tech-

nology of terra cotta production is testified to by his factory managers and employees. They say that he knows the details and that his judgments are well balanced.

President Eskesen's advancement to the presidency of this SOCIETY and of several business and industrial organizations was accomplished because he has acquired knowledge and has executive ability. He is a leader of men.

Recognition of another sort was given Mr. Eskesen last summer. It was in recognition of his talents, but more, it was in recognition of the cordial working relations he has established with the leading architects of America and of his exceptionally pleasing personality. The King of Denmark knighted Mr. Eskesen because of his substantial humanitarian interest in Danish immigrants. This group of architects honored him because of the services rendered in their behalf and because they found it pleasant and profitable to be with him: a personal charm based on ability, helpfulness, and culture.

A group of fifty American architects left New York May 22 on the S. S. American Banker. They had chartered the ship for their exclusive use. They had only five guests; a stag affair.

These fifty architects are disciples of the École des Beaux Arts, Paris. Their purpose in going to Paris was to commemorate former days of the school and to present to the school a flagpole, the foundation of which was designed by Frederic C. Hirons. The pole was erected and dedicated with ceremonies of great local interest in the courtyard of the school.

The party was in Paris two weeks, returning to New York on a privately chartered steamship.

The roster of architects in that party reads like a roster of famous living architects of America.

Mr. Eskesen, once a humble shop hand but now an industrial and business leader, was a guest of this group of architects in recognition of his talents and culture. Mr. Eskesen has so impressed the architects for whom he makes terra cotta that they wanted him with them as their guest, a recognition rare, but a recognition well deserved.

We, members of this SOCIETY, may well be proud that along with his many industrial and business duties, Mr. Eskesen takes time to follow the details of the business affairs of this SOCIETY. We may well be proud that he takes the time for human affairs and for culture. We are proud of the recognition which this group of distinguished architects expressed by inviting him to be their guest at the dedicatory ceremonies at École des Beaux Arts.

OUR 1932 ANNUAL MEETING

In Washington, Hotel Willard, the week of February 7, this SOCIETY is going into sessions which will be attended by America's most critical and

well-informed solons. The SOCIETY will be judged. If found wanting it will be the fault of those individuals who have data on which they could write papers.

You, individually, are responsible. You, individually, will be the loser if our programs are not of the highest possible character.

The Local Committee is arranging an interesting schedule. You will have the opportunity to meet President Hoover and many others concerning whom you are well informed. You are going to the places and see the things that make Washington the mecca of tourists.

The Division program committees are hard at their jobs.

Are you doing your bit to make this 1932 Annual Meeting another one in the series of increasingly successful meetings which this SOCIETY has held?

FUTURE ACTIVITIES OF THIS SOCIETY

The purpose of the AMERICAN CERAMIC SOCIETY is to foster the advancement of the ceramic arts, science, and technology. To accomplish this to the fullest extent the SOCIETY must give attention to product development and promotion. Ceramic product development is the end purpose of all fundamental and applied ceramic research and plant development. Not to go the whole way from fundamental science to ware produced would be lessening the effective purpose of and profit from laboratory research.

It is not an idle thought that at some future date this SOCIETY will place an advertisement in engineering journals reading as follows:

Build Roads and Sewers That Will Last 100 Years

(The Romans did it. We Americans can do it.)

Give long, safe, and smooth service, with lowest maintenance costs.

(1) Good foundations. (2) For the top wearing plates, culverts, and sewer pipe, use materials that will not crumble or rust away.

Insure against destruction the top wearing plates, culverts, and sewers in our roads as we do all other public property.

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AMERICAN CERAMIC SOCIETY, Columbus, Ohio

This being an industrial technical society it must take its place in the ceramic family as a twin brother with the ceramic trade associations; the trade associations to take care of the trade, tariff, and traffic problems; this SOCIETY to take care of the fundamental science and technology of ceramic ware compounding and processing; both the trade and technical groups co-laboring on those problems in which both have a vital interest.

Problems that concern both the trade and the technical organizations are those such as production costs, quality of ware, product development, and product promotion.

Gerard Swope's proposal on September 16 for the "stabilization of

industry" before the National Electrical Manufacturers Association and Victor V. Kelsey's proposal in the September *Ceramic Age* for "Harnessing the Law of Supply and Demand" are along the same line of collective coördination without restriction of individualism as we have often proposed for the ceramic industries. Our SOCIETY with its industrial Divisions has for ten years showed that collective coördination without restriction of individualism is a successful scheme.

When this collective coördination scheme for trade associations is brought into being, this SOCIETY must be a part of it. This is logical and economical. The SOCIETY must be ready to shape its activities and policies into line with this modern scheme of affairs. Cartels in Europe are the vogue.

We need more industrial leaders who, like O. W. Renkert, are actively planning and proposing a master ceramic organization.

THE CLAY PRODUCTS INSTITUTE OF AMERICA

The first number of the *Journal of the Clay Products Institute of America* has been issued. Compliments and congratulations.

The Institute is laudable in purpose. Its promoters are sincere. We wish it success. We hope that it will be able to bring several ceramic construction product trade associations into a harmoniously working group.

BALLYHOO

If you have not read the newest humor magazine we recommend that you do so without delay. One cannot be so low spiritually as not to enjoy thoroughly this bit of freshness. One cannot be in such high spirits as not to appreciate the novel humor of this magazine.

The sales of this magazine have been unprecedentedly large. Issue No. 1 came out last August when the economic skies were the cloudiest. The subsequent issues came along ahead of schedule, the November copy appearing late in September.

From 150,000 copies of the first issue in August, the fourth issue was more than 1,000,000 with a sellout at all the news stands.

The magazine has not carried any paid advertisements. The annual subscription is $1.80; single copies 15 cents. The publishers do not encourage subscriptions. They take themselves too humorously for that.

The point to be made here is that there are over a million persons who have paid 15 cents per copy or a total of over $150,000 for an issue of this Journal at a time of shrinking incomes and decreased salaries.

How was this immense sale made possible? *Ballyhoo.*
Each person who read it told others. *Ballyhoo.*
A personal indorsement. *Ballyhoo.*
No one discrediting. *Ballyhoo.*
Everybody boosting. *Ballyhoo.*
No selfishness involved. *Ballyhoo.*

If the members of this SOCIETY would go out for corporation members in this unselfish ballyhoo fashion, what a SOCIETY this would be.

ACTIVITIES OF THE SOCIETY

ANNUAL MEETING OF THE AMERICAN CERAMIC SOCIETY WASHINGTON, D. C.

Program for Baltimore Day

February 11, 1932

Leave Washington, Union Station, 9:10 A.M. via special cars over B. & O. R.R.

Arrive Baltimore 10 A.M. Buses will take the party through the center of the city to City Pier and aboard the "Steamer Latrobe" as the guest of the Mayor, Hon. Howard W. Jackson, for a view of the harbor and a number of historical points of interest. Loud speakers will be used, and a member of the Association of Commerce will give a lecture en route. A splendid view of the Chesapeake Bay. A stop will be made at the historic Fort McHenry.

The party will lunch at the Emerson Hotel.

After lunch the party will visit the famous ceramic collection at the Walters Art Gallery. This is a private gallery, one of the world's finest.

Dinner at the Emerson Hotel at 5:30 P. M.

At 7 P. M. the party will be the guest of Frank H. Reagan, President of the Locke Insulator Corporation, to view an electrical demonstration at the high-voltage laboratory: Man-made lightning, 3 million volts, and the action on high-tension insulators; a miniature city will be destroyed by lightning; a number of interesting tests by high voltages; also a collection of early electrical porcelains showing the development over forty-five years. The plant will be open to view the tunnel kiln.

Art Exhibit at Washington

The exhibition of the Art Division held in Cleveland was very successful. The one to be held in Washington next February should be still better. It is planned that the exhibition will be shown in a Washington gallery under professional conditions.

The Exhibition Committee, composed of Myrtle M. French, Marion L. Fosdick, and William E. Ross, is suggesting five main groups to be considered by those planning entries. They are as follows:

(1) Experimental processes in any field of ceramics which might be useful to a manufacturer or craftsman carrying on mass production.
(2) Pieces so designed that they would be practical for mass production.
(3) Well-rendered designs which may be accompanied by an executed portion of the design or well-rendered designs using standard ceramic products.
(4) Ceramic models of objects too large to exhibit.
(5) Individual pieces.

Hitherto, the exhibition has been made up mostly of the last group. This year the craftsmen are urged to contribute also toward the other four groups.

Each person, by paying an entry fee may exhibit eight pieces in group five. Those also interested in helping solve the problems of design for mass production will be allowed to exhibit free, eight pieces classified under groups one to four, inclusive.

Except in the case of schools, no group of potters shall exhibit under a group name, but a group working together may exhibit as individuals. It is hoped that work accepted at the Sloane Exhibition and left unsold will be kept to be shown in this exhibition.

Definite details of the exhibition will be sent later when all of the arrangements have been made. Every member of the Art Division is urged to contribute to the exhibition.

NOMINATIONS OF THE STRUCTURAL CLAY PRODUCTS DIVISION

In accordance with Section 2, Article V of the By-Laws of the Structural Clay Products Division, the Nominating Committee has submitted to me the following nominations for officers of the Division:

Chairman: Amos P. Potts, Brazil, Ind.
Vice-Chairman: H. R. Straight, Redfield, Iowa.
Secretary: Marion Blair, Terre Haute, Ind.

Additional nominations may be made as provided in Section 3, (*a*) and (*b*), Article V, as published in the *Bulletin*, April, 1931. HOWELLS FRÉCHETTE, *Chairman*, Structural Clay Products Division.

NEW MEMBERS RECEIVED IN SEPTEMBER

CORPORATION

A C Spark Plug Co., Taine G. McDougal (voter), Flint, Mich.
Ceramic Color and Chemical Mfg. Co., W. F. Wenning (voter), P. O. Box 81, New Brighton, Pa.
Lee Clay Products Co., Inc., M. S. Bowne (voter), Clearfield, Ky.
J. C. Steele & Sons, H. O. Steele (voter), Statesville, N. C.

PERSONAL

B. K. Bhaduri, 5-1-A, Gopal Nagar Rd., Calcutta, India; Bengal Potteries, Ltd.
Willard K. Carter, 1259 S. High St., Columbus, Ohio; National Aluminate Corp.
Victor Joseph Duplin, Jr., 10 College Ave., Medford, Mass.; Industrial Research Fellow, Massachusetts Institute of Technology.
M. M. Leighton, 305 Ceramics Bldg., University of Illinois, Urbana, Ill.
S. H. Renton, 12426 Mendota, Detroit, Mich.; J. B. Ford Co., Wyandotte, Mich.

STUDENT

Jack A. Cunliffe, University of Washington, Seattle, Wash.

Membership Workers' Record

PERSONAL		CORPORATION	
F. C. Flint	1	Office	4
R. M. King	1		
F. H. Norton	1		
		STUDENT	
E. P. Poste	1	Hewitt Wilson	1
Office	1		—
Total	5	Grand Total	10

ROSTER CHANGES IN SEPTEMBER

PERSONAL*

Anderson, L. S., R. F. D. No. 1, Crystal Lake, Ill. (Terra Cotta, Ill.)
Arnold, Howard C., 119 Summit Ave., Jenkintown, Pa. (1131 Foulkrod St., Philadelphia, Pa.)
Burchfiel, B. M., Gladding, McBean & Co., 2901 Los Feliz Blvd., Los Angeles, Calif. (Alberhill, Calif.)
Devol, James C., Louisville Products Co., 1414 South 13th St., Louisville, Ky. (A. B. Stove Co., Battle Creek, Mich.).
Eatherton, Clarence Z., Botfield Refractories Co., Swanson and Clymer Sts., Philadelphia, Pa. (Buckeye Clay Pot Co., Toledo, Ohio.)
Hermann, Max, 338 Burnett St., New Brunswick, N. J. (735 N. Sixth St., Allentown, Pa.)
Hotchkiss, C. A., Lilly Chapel, Ohio. (211 Newton Ave., S. W., Canton, Ohio.)
Humphrey, Ingraham, 41 Jewel St., Rochester, N. Y. (Canisteo, N. Y.)
Kempf, W. C., Box 72, Metuchen, N. J. (888 De Graw Ave., Newark, N. J.)
Longenecker, H. L., 204 W. Morgan St., Raleigh, N. C. (P. O. Box 1457, Wilson, N.C.)
McHose, M. M., 144 Rockview Ave., Plainfield, N. J. (181 Amboy Ave., Metuchen, N. J.)
Pole, Gordon R., Pittsburgh Plate Glass Co., Creighton, Pa. (Bureau of Standards, Washington, D. C.)
Riley, R. J., R. F. D. No. 1, Crystal Lake, Ill. (Terra Cotta, Ill.)
Rudd, Richard D., 905 N. Fifth St., Phoenix, Arizona. (144 E. Bluff, Marseilles, Ill.)
Scholes, S. R., 1565 Lincoln Rd., Columbus, Ohio. (Fostoria Glass Co., Moundsville, W. Va.)
Sheerer, Mary G., 2122 Auburn Ave., Apt. 10, Cincinnati, Ohio. (H. S. Newcomb College, New Orleans, La.)
Shoemaker, George W., Ar-Ke-Tex Corp., 17 N. Meridan St., Indianapolis, Ind. (Clay Products Co., Brazil, Ind.)
Soler, Gilbert, 52 W. Northwood Ave., Columbus, Ohio. (Republic Research Corp., Massillon, Ohio.)
Thomas, John H., Y. M. C. A., 5th and Vine Sts., Evansville, Ind. (2 W. Third St., Alton, Ill.)
Woodhouse, Charles D., Mocalno, Mono County, Calif. (Laws, Inyo Co., Calif.)

NOTES AND NEWS

CERAMIC SCHOOL NOTES

University of Illinois Short Course[1]

Plans are under way for the next Short Course to be held by the Department of Ceramic Engineering at the University of Illinois in January.

The practice of holding a Short Course dates from 1912 and it has always been looked forward to with a great deal of interest by many men from the industry who have been glad to take advantage of the opportunities for attending the lectures which are given on topics relating to the practical operations of the ceramic industry. The courses are designed especially for the benefit of the managers, superintendents, foremen, engineers, and plant men, and they are presented in such a way as to be easily understood by the hearers. A technical education is not necessary.

*Addresses within the parentheses represent the old addresses.

These roster changes which are published each month may be checked against the complete Membership Roster which appeared in the July, 1929, issue of the *Bulletin*. Copies of this issue may be obtained from the Secretary's office, price $2.00.

[1] C. W. Parmelee, Head of the Department of Ceramic Engineering, University of Illinois.

UNIVERSITY OF ALABAMA[1]

The School of Chemistry, Metallurgy, and Ceramics of the University of Alabama was organized in September, 1929, with Dr. Stewart J. Lloyd as Dean. This arrangement was adopted to obtain a better coördination of the three subjects and students registered in the School are required to take fundamental courses in all of them. In the senior year there are a number of options which permit specialization. At the present time over 50 students are registered in the different ceramic courses and it is expected that there will be a larger number next year due to a marked increase in the enrollment of sophomores.

The ceramic laboratories occupy more than 5000 square feet of floor space, to which is added a well-equipped chemical laboratory. The principal items of equipment are a large gas-fired test kiln capable of reaching cone 20, fusion furnace of the Mellon Institute design, frit furnace, Mueller roll press, tile press, ball mill rack with six pebble mills, six bucket blungers, electric drier, large gas-fired drier, jaw crusher, disk pulverizer, and a good sized air compressor. The laboratory is equipped with control instruments such as a draft gage, psychrometer, Orsat apparatus, portable potentiometer, three-point automatic temperature recorder, and standard testing sieves.

A new spray booth, small electric muffle furnace and silicon carbide muffles have been purchased as it is planned to do some work on vitreous enameling. The laboratory work has so far consisted of clay testing, ceramic bodies, glazes, and special refractories.

In addition to teaching, the department has done considerable commercial research and assists the Department of Fine Arts with the firing and glazing of art pottery. Research work is being done at the present time on the use of soluble silicates in glazes and also on raw lead crystalline glazes. Some work will be started in the near future on a study of the particle size of ceramic materials.

COLLECTIVE ORGANIZATION OF INDIVIDUAL INTEGERS

The following communication from Karl T. Compton, Chairman of the Governing Board of the American Institute of Physics, has recently been sent to the members and Fellows of the American Physical Society, the Optical Society of America, the Acoustical Society of America, and the Society of Rheology.

By action of the Councils of your several societies, the American Institute of Physics has now been established under a managing board, composed of three representatives elected by the council of each of the four coöperating societies. The Institute of Physics is to be an agency for studying the common problems of the organizations representing physics in America and for undertaking thereafter such functions as the coöperating societies may assign to it. The subjects that the Institute has already been commissioned to study are briefly the problems of publications in physics, their better correlation and adaptation and means of better financial support; the questions of helpful contacts and closer relations among all the organizations and groups, local or extended, interested in physics; and the subject of the relations of physics and physicists with the public, which resolves itself on the one hand into interesting and informing the public by use of effective channels of publicity and on the other hand to seeking more support for physics from the public.

An essential part of the plan of the Institute was securing a competent full time Executive Secretary or Director to lead its work. The Governing Board takes pleasure in announcing the appointment as Director of the Institute of Physics Henry A. Barton, formerly Research Engineer with the American Telephone and Telegraph Co., Ph.D.,

[1] T. N. McVay, Professor of Ceramics, University of Alabama.

Princeton, 1925, National Research Fellow in Physics at Harvard University, Research Fellow at the Bartol Foundation, and recently Assistant Professor of Physics at Cornell University. Dr. Barton began his work on October 1, 1931, with offices at 654 Madison Ave., New York, N. Y.

Since a most pressing problem before the Institute is that of finding a plan which will give the most effective service in publications in physics, and which at the same time may gain adequate financial support for these publications, the Governing Board has requested the University of Minnesota to consent to the part-time release of Professor John T. Tate during the coming year in order that he may work in collaboration with Dr. Barton in preparing a coördinated publication plan for presentation to the Governing Board. The University of Minnesota has agreed to this under arrangements that have now been effected.

The Chemical Foundation has undertaken to finance the initial stages of the Institute of Physics and has generously afforded office space and clerical assistance to the Institute. Wm. W. Buffum, Manager of the Chemical Foundation, has at the request of the Governing Board agreed to serve as Treasurer of the Institute of Physics.

The Institute of Physics has come into being in direct response to a generally felt and widely expressed desire that means be developed for profiting by more concerted action and broader opportunities of association and intercourse on the part of the rapidly increasing body of physicists, and for presenting a more united front for physics before the public. In several conferences of representative physicists it was agreed that the most effective and feasible method of coördinating the activities of physicists and of coöperating for the advancement of physics would not lie in the direction of a merging of all existing societies into one large society, but would rather take the form of a coöperative agency to handle, for the coöperating societies, such matters of business, of policy and of organization as might increase interest in and support for physics. The steps leading immediately to the formation of the Institute of Physics were taken after definite encouragement by the Chemical Foundation. Mr. Francis P. Garvan, president of that Foundation, stated to a committee of the American Physical Society that the Chemical Foundation would be ready to lend support, financially and otherwise, through the most suitably constituted and widely representative agency, to the advancement of physics in America.

This plan of an American Institute was first approved in principle by the American Physical Society and by the Acoustical Society of America at their meetings last December. It was approved in more detail by the councils of the coöperating societies following a report in March, 1931, of a joint committee.

The Director of the Institute plans to be present at meetings of the several societies. It is hoped that members will discuss freely with him the plans of the Institute. Dr. Barton will be glad to have members call upon or communicate with him at the office and particularly invites your correspondence and suggestions as to the work and opportunities of the Institute.

DECEMBER MEETING OF SOCIETY OF RHEOLOGY

Eugene Bingham, Chairman of the Program Committee, Society of Rheology, has announced the tentative program for the Third Annual Meeting of the Society, to be held in Rochester, N. Y., December 28 to 30, 1931. There will be room on the announced program for additional papers from any who wish to take part in this meeting. Reservations should be made by those planning to attend the meeting by notifying Dr. S. E. Shepard, Rochester, N. Y.

(1) Symposium on the Rheology of Metals

(1) A Mathematical Application of the Laws of Plasticity.
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(2) General

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(10) Viscosity Studies of Synthetic Resin Solutions.
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(12) A Survey of Rheological Theories.
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(13) The Application of the Theory of Laminar Flow to Viscometers with Short Capillaries.
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(14) The Viscosity of Glass. (provisional)
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(15) Oiliness of Steam Turbine Oils.
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(16) The Cause of Fluctuations in Rising Mixtures of Gas and Liquid.
By J. Versluys.
(17) Problem in plastic flow, title to be announced later.
By E. O. Kraemer and Dr. Miles.
(18) Dimensional Analysis Applied to Plastic Flow.
By M. D. Hersey.
(19) Theories of Viscosity.
By S. B. Stone.
(20) The Status of Viscosity Measurement.
By the Committee on Standards and Definitions.

The paper ready for publication should be in the hands of the Editor by November first, with a brief abstract.

CALENDAR OF MEETINGS

Organization	Date	Place
American Assn. for the Advancement of Science	December 28, 1931 to January 2, 1932	New Orleans, La.
AMERICAN CERAMIC SOCIETY	February 7–13, 1932	Washington, D. C.
American Chemical Society	March 14–18, 1932	New Orleans, La.
American Engineering Council	January 14–16, 1932	Washington, D. C.
American Face Brick Assn.	November 4–6	West Baden, Ind.
American Institute of Chemical Engineers	December 9–11	Atlantic City, N. J.

Common Brick Mfrs. of America	February 1–6, 1932	Louisville, Ky.
Electrochemical Society	April 21–23, 1932	Baltimore, Md.
Gypsum Assn.	December 9	Chicago, Ill.
National Assn. of Manufacturers of Pressed and Blown Glassware	March 8, 1932	Pittsburgh, Pa.
National Exposition of Power and Mechanical Engineering	December 5–10	New York, N. Y.
National Glass Distributors Assn.	December 1–3	Pittsburgh, Pa.
National Paving Brick Assn.	February 10–12, 1932	Chicago, Ill.
Ohio Ceramic Industries Assn.	November 6–7	Columbus, Ohio
Sand-Lime Brick Assn.	February 3–4, 1932	Washington, D. C
Scientific Apparatus Maker of America	May, 1932	Wernersville, Pa.
Society of Rheology	December 28–30	Rochester, N. Y.
Structural Clay Tile Assn.	February 17–19, 1932	Chicago, Ill.
Taylor Society, Inc.	December 2–4	New York, N. Y.
Tile & Mantel Contractors' Assn. of America, Inc.	February 9–12, 1932	Rochester, N. Y.

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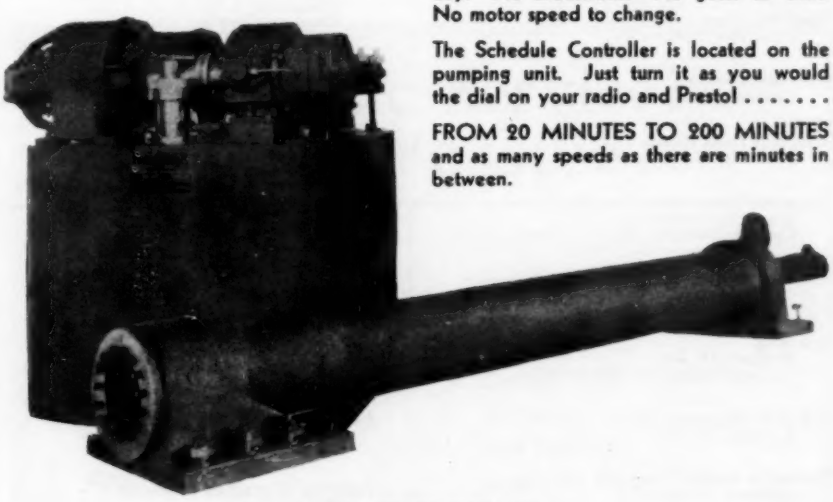

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H

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I

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L

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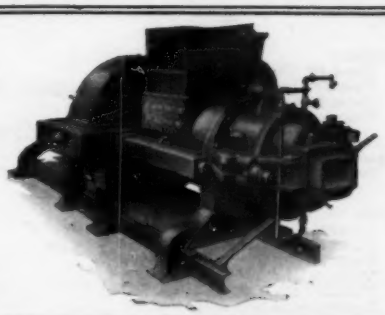

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O

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P

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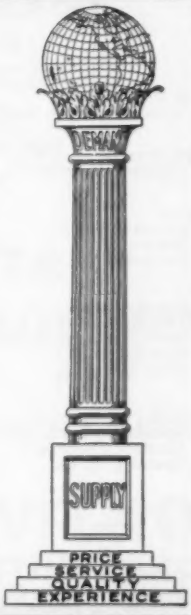

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W

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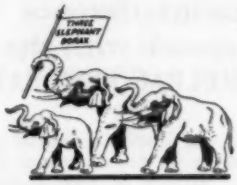

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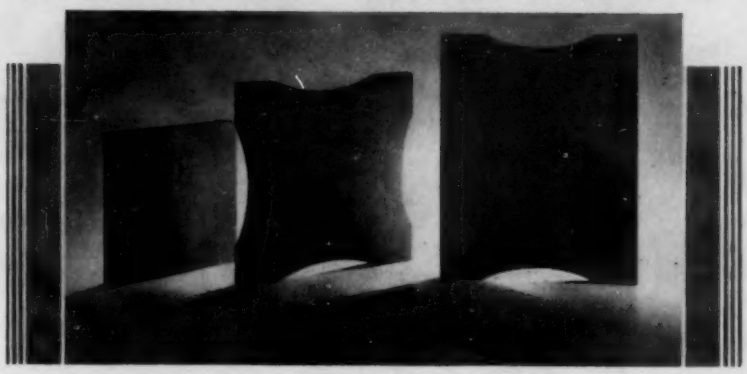

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